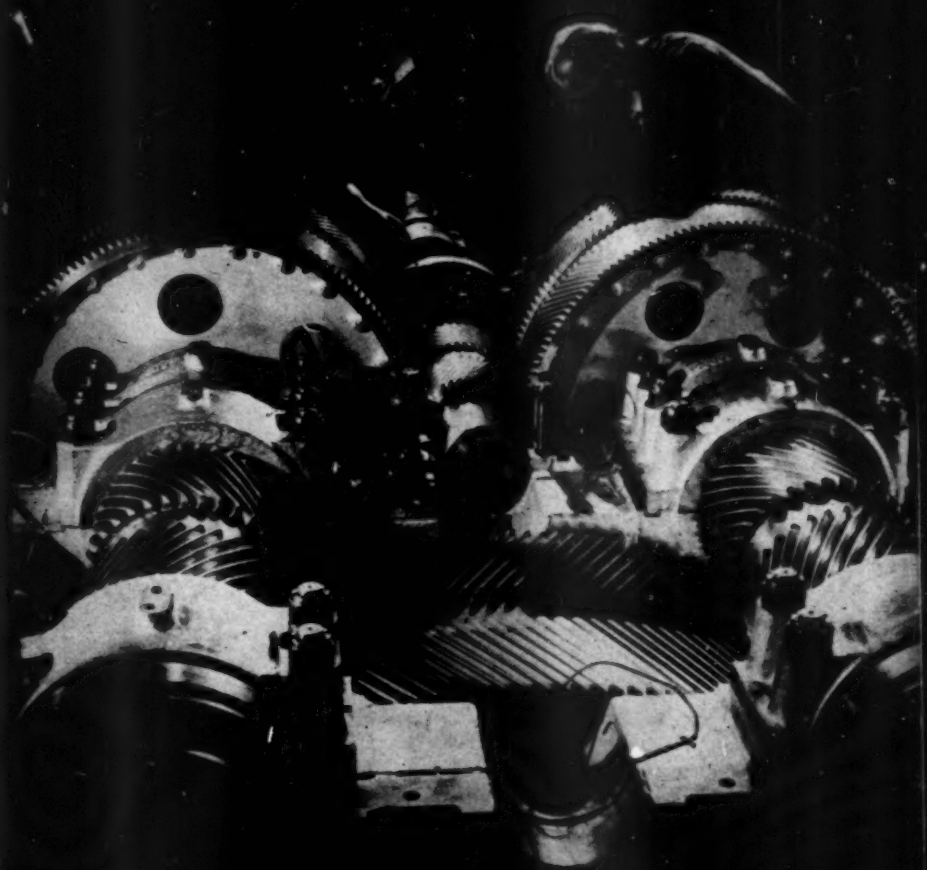

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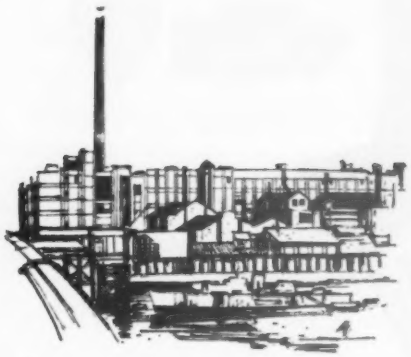

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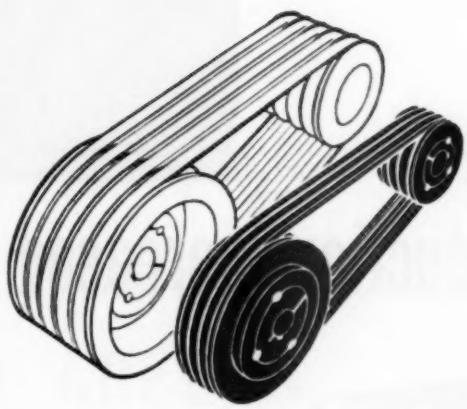

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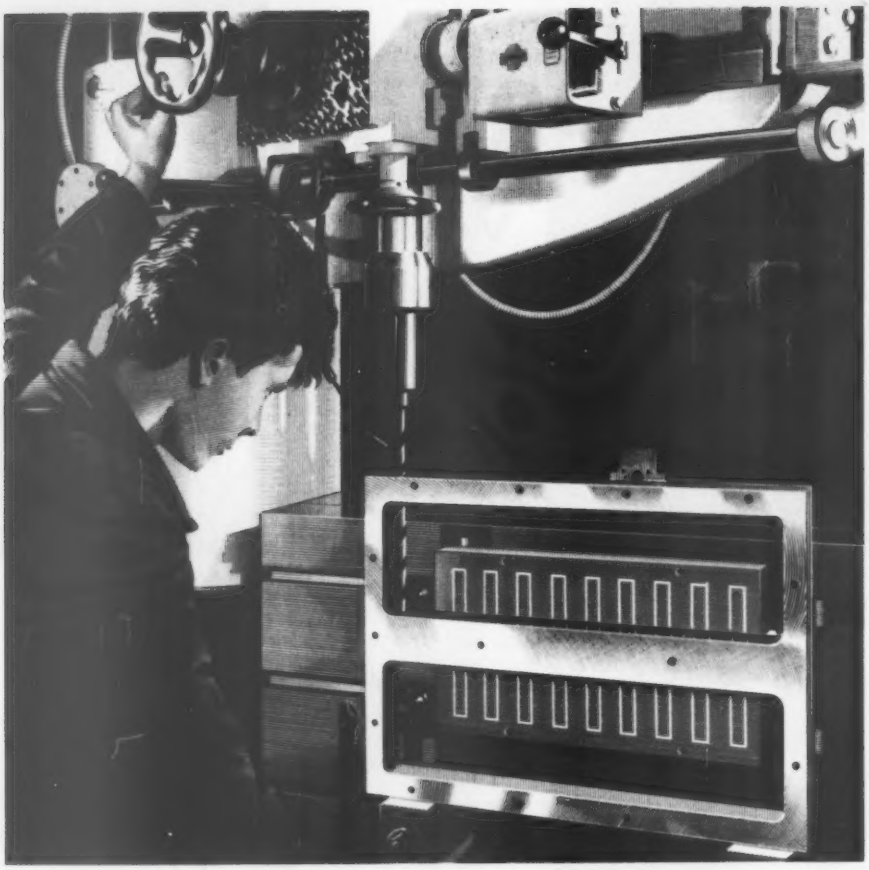

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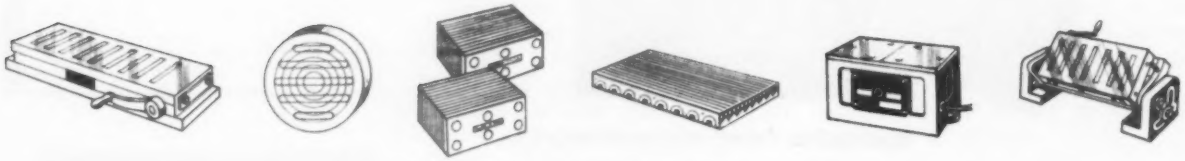

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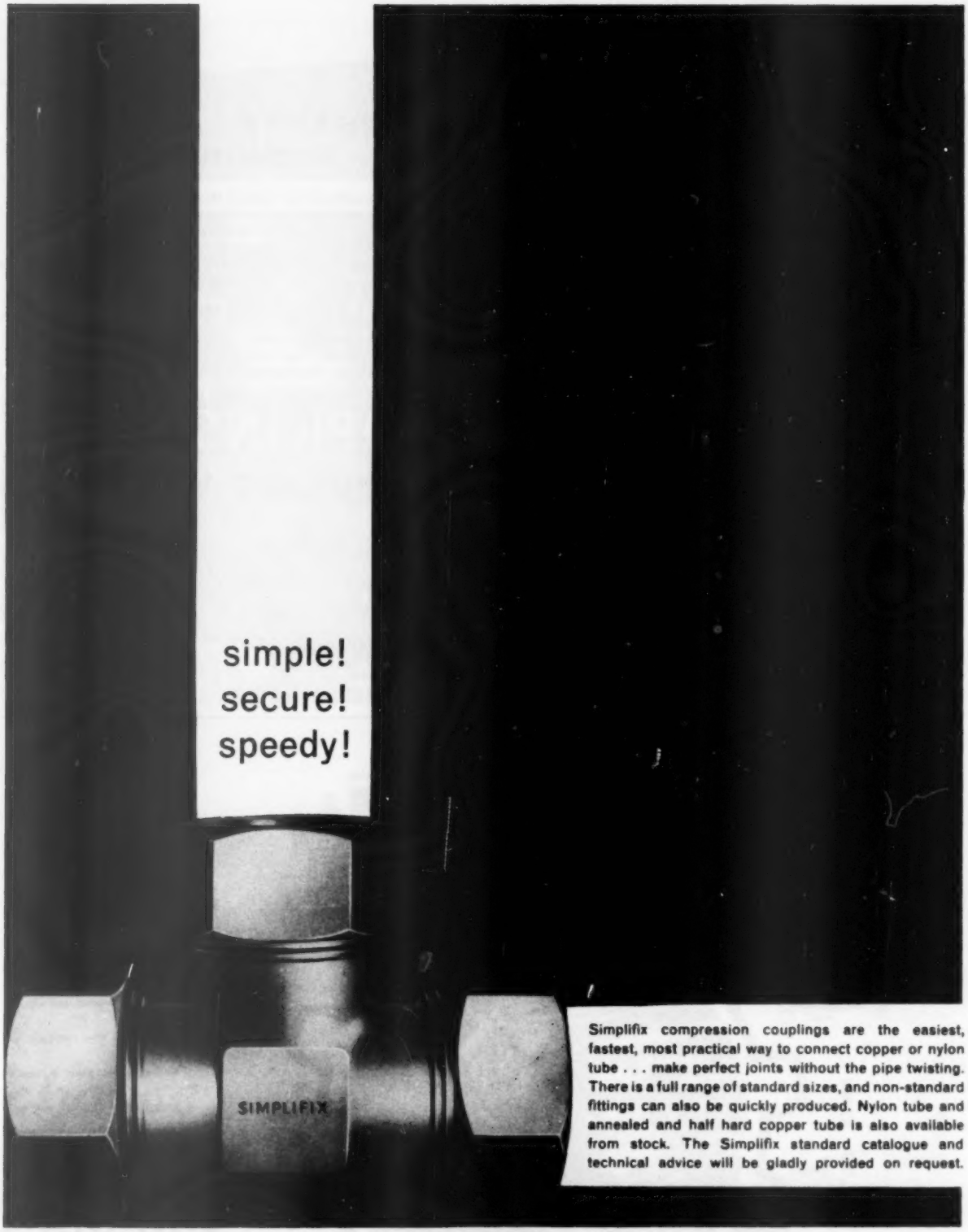

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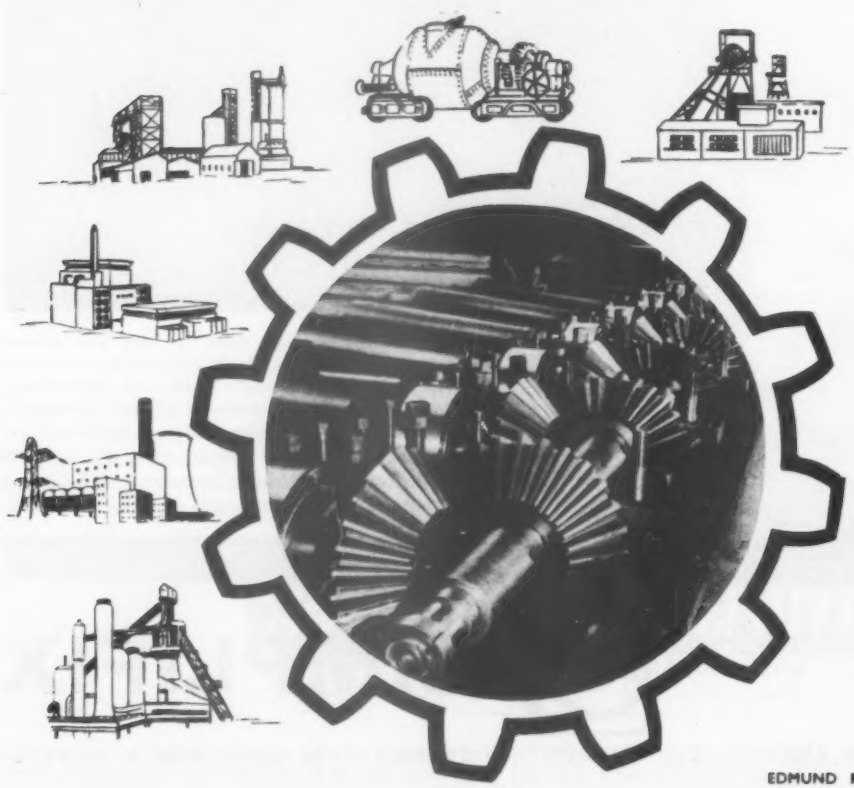

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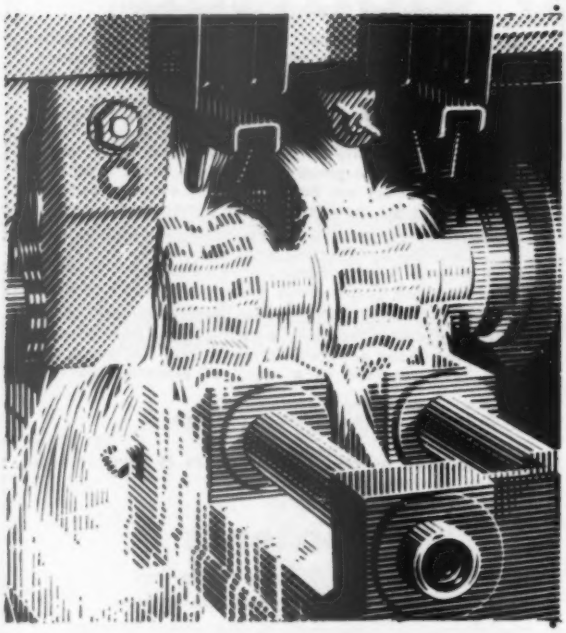

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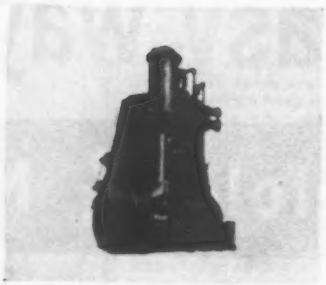

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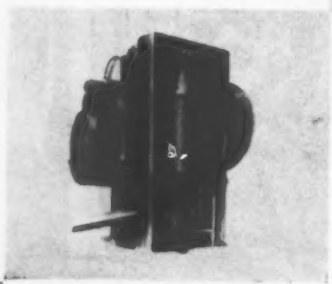

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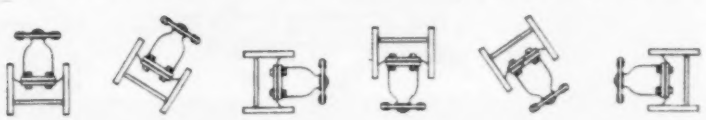

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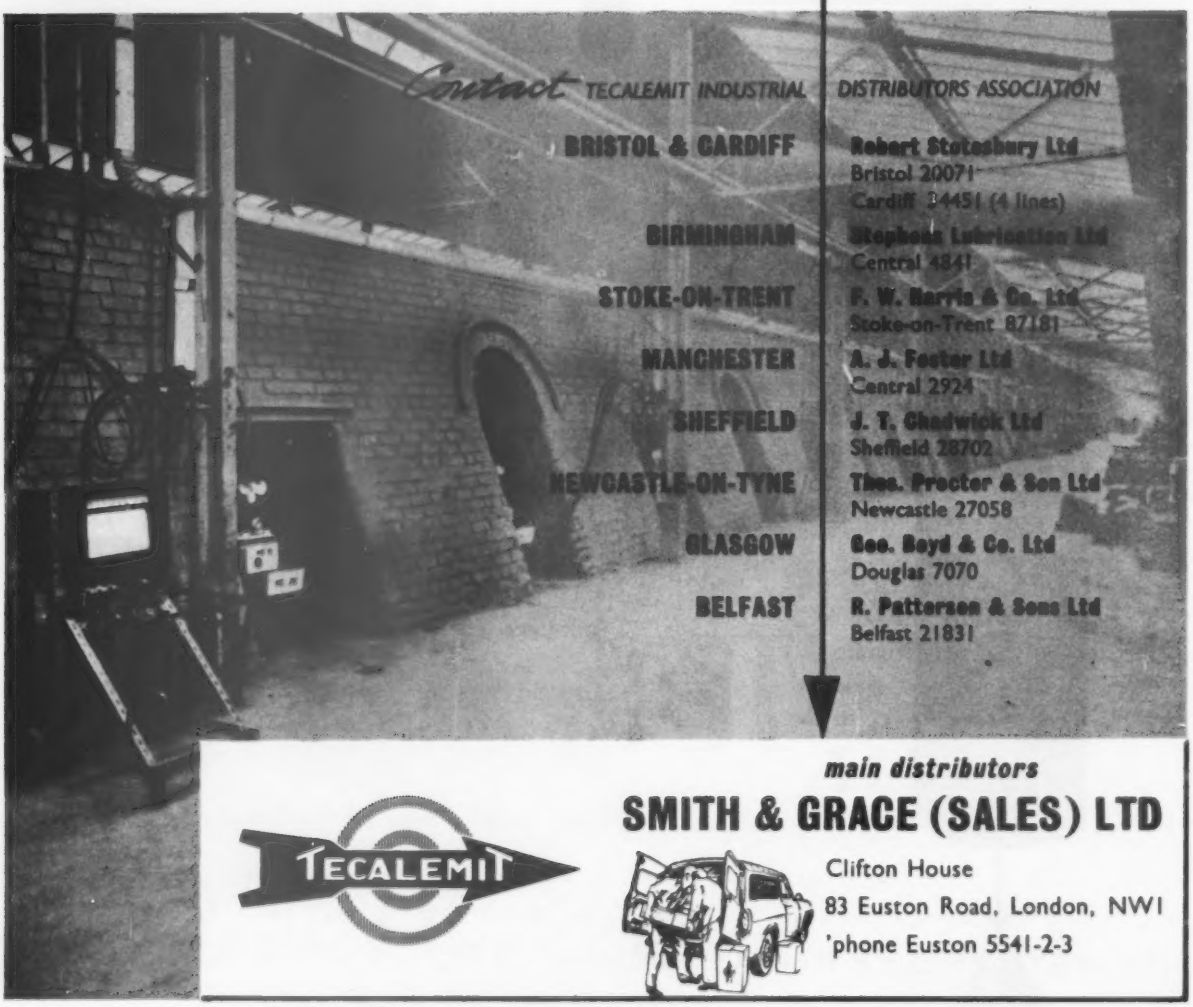

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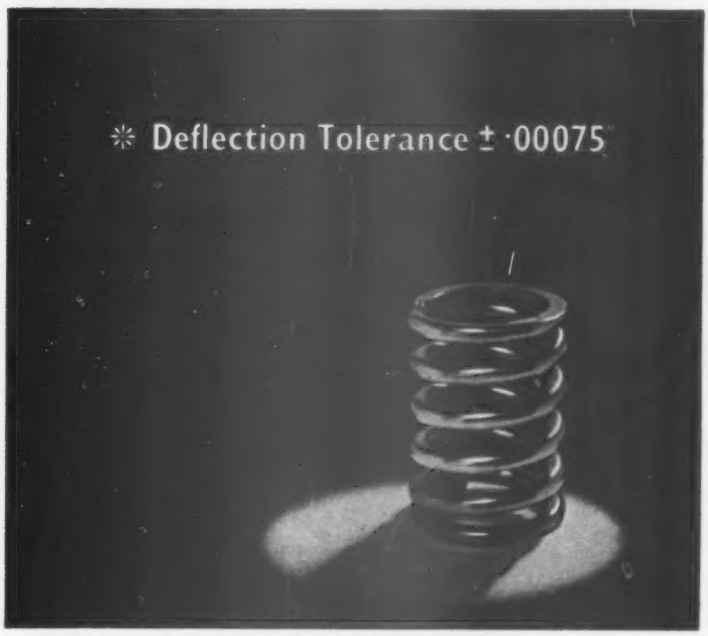

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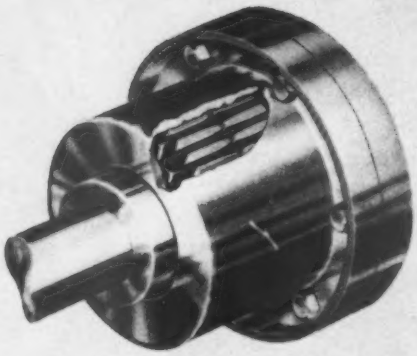

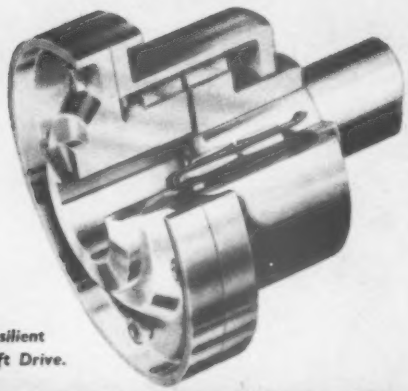

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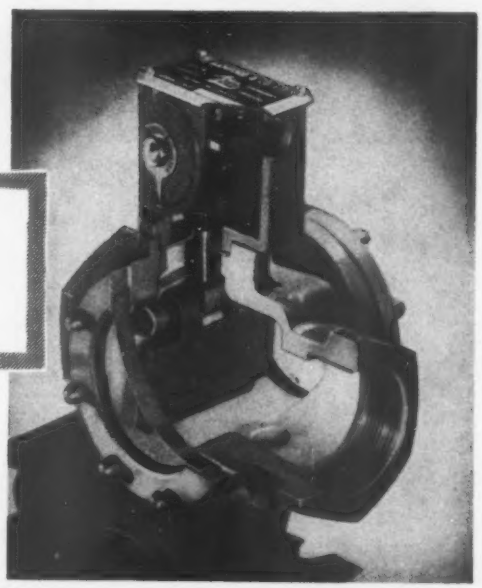

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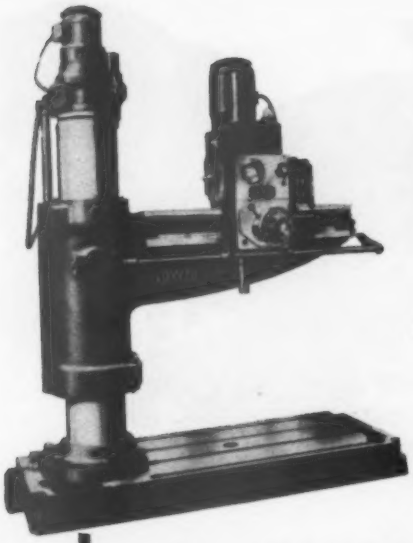

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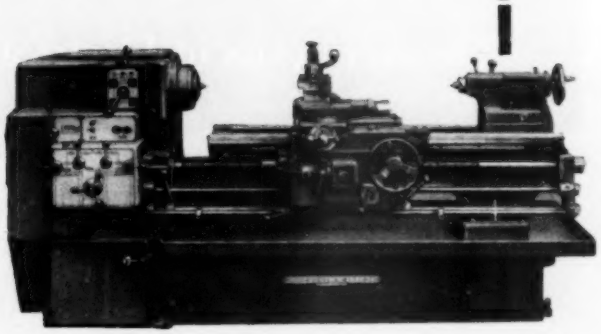

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Mechanical World

AND ENGINEERING RECORD

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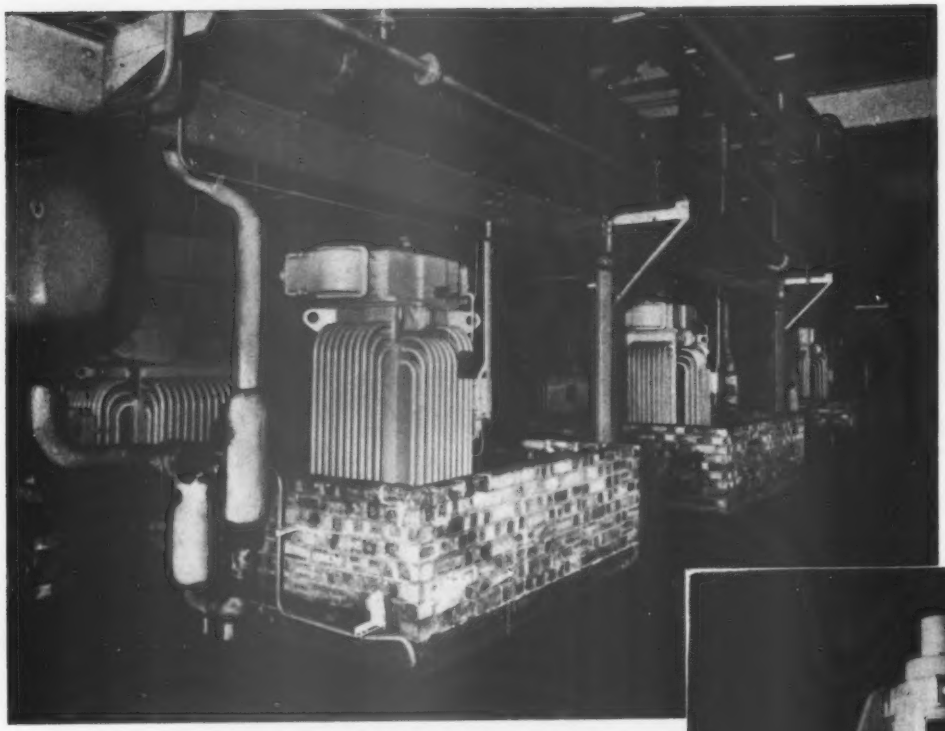


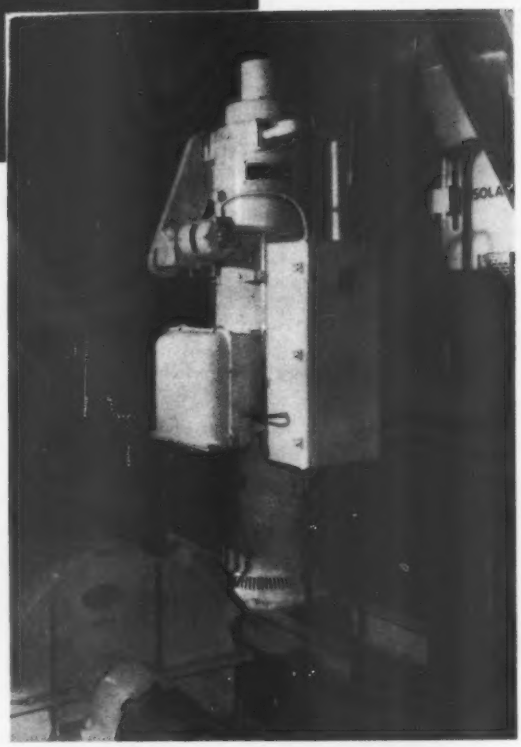
Battery of eight 100 kVA oil-cooled induction regulators for heater control. (Imperial Chemical Industries Ltd.)

For efficient, adaptable, *stepless* voltage variation

The induction regulator has a number of advantages for the provision of a continuously-variable voltage. It has a high efficiency and low reactance, does not cause harmonic distortion or low power factor, operates without sliding contacts and is readily adaptable to various forms of automatic control.

L.S.E. have had considerable experience in the manufacture of induction regulators and can offer equipments for capacities up to about 5,000 kVA, either low or high tension.

Typical applications include heater control, automatic power factor correction (in conjunction with condensers), line voltage control for test purposes, etc. Fuller details are available in Publication 155



One of six 35 kVA forced-air-cooled single induction regulators, with integral transformer and fan, controlling hot traps at the Dounreay Fast Reactor. (United Kingdom Atomic Energy Authority).

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Mechanical World —— February 1962

Insurance for Inventors

THE history of invention is punctuated by the solemn pronouncements of eminent authorities as to the impossibility of ideas which later proved successful. At less exalted levels the reluctance to accept novelty is exemplified in the story about the old lady who told George Stephenson that his engine would never go, and who on seeing it in motion said equally emphatically that it would never stop. That there is a long list of illustrious names in the history of invention despite such discouragement is a measure of the quality of the great men among inventors. Do only great men produce the most worthwhile inventions? Is the important invention always the product of a brain large enough to overcome all obstacles? It might have been so in the past, but today some major innovations come out of the big laboratories and the originators are not put to the full rigour of the test. And sometimes they are a team and not an individual—a dimensional complication which for the moment puts the picture out of perspective (perhaps out of perception). There is one fact which is significant however, and that is the greater readiness with which the unusual invention is taken up in the United States as compared with the Old World. We know of one inventor who so regarded this as axiomatic that he straightaway sought promotion over the Atlantic, and found ready support there.

That there is an adverse circumstance attendant upon true invention is almost self-evident. The radically new idea is difficult to grasp by anyone who has not thought about it as much as has the inventor, and it often cuts across the pre-conceived ideas, practices and investments of those who might be expected to be interested but who cannot readily accept wholesale scrapping of their own life's work.

It has been in the news lately that a company of major size has been formed expressly to commercialize inventions. That finance should come now from non-technical sources is new hope for the inventor. Insurance companies are concerned in the venture, and in addition to being wealthy they are most astute investors. They put their money where it will do best, and out of the welter of present day scientific discovery there is a very great possibility of technological application—which of course means invention.

Thus from having to go out and seek capital to float their inventions, inventors, or some of them—many we hope—are now in the happy position of having capital looking for good inventions to develop. There is a first-class national objective in this—prestige, industrial supremacy and the promotion of prosperity—but it is big business too and there is every reason why the profitable cream from British inventions should be skimmed off in the country of origin and not abroad as has so often previously been the case.

LOG SHEET

Automatic Feed Lines

The installation of a new automatic transformer core plate cutting machine in the Distribution Transformer Department of Ferranti Limited, West Gorton, Manchester, marks the culmination of an intensive period of development work on automatic feed lines for producing transformer core laminations. At the West Gorton factory, distribution transformers of up to 1500kVA, employing lock wound, mitred and conventional cores, are produced by flow-line production methods.

In contrast to the pilot line, produced in 1958 by B. H. P. Machine Tool Company Limited, Birmingham, the recently installed feed line, designed and manufactured by Humphris & Sons Limited, Poole, Dorset, is completely integrated and is approximately three times faster, i.e., 120 ft per min. Prediction of cut length is positive and accurate, and generally the changeover time in setting different lengths is faster. It is used for the production of conventional core and mitred core laminations. It comprises a control cabinet, loop control unit incorporating a photo-electric cell, a decoiler, a loop support unit fitted with a micro switch to control a no-loop condition, a feeding and measuring machine incorporating pinch rolls, measuring rollers, and entry and exit guides, a Humphris CP25 Pressmaster open front power press complete with an oscillating mitre cutting tool, and a run-out table and stacking unit for the finished transformer laminations. A feature of the oscillating press tool, which is fitted with tungsten carbide shear blades, is that air flotation is used to assist free angular movement through 90° giving alternate 45° mitre cuts.

Although the arrangement of units is similar, the method of measuring the length of material to be cut differs considerably. In the original line, a perforated 12 in. diameter Tufnell disc with 120 divisions is mounted at one end of the combined feeding and measuring rollers. One interruption of the light beam from a photo-electric cell caused by the disc rotating, which corresponds to a $^{1}/_{64}$ in., actuates a dekatron counter on the Londex control panel. There are four selector switches on the panel, each with a dial counting up to 10, and these are set to the number of pulses which correspond to the required strip length. The first dial represents 10 units, the next 100 and so on, and each equals 0·015 in. or a $^{1}/_{64}$ th.

Automatic feed line used for the production of conventional transformer core and mitred core laminations

Massey Centenary

B. & S. Massey Limited of Openshaw, Manchester, who have been manufacturing forging and drop forging plant for 100 years, recently celebrated their centenary.

In 1861, with a capital of £500, the brothers Benjamin and Stephen Massey built a small works at Openshaw with the intention of building steam engines and machinery for the cotton industry. When the American Civil War interfered with their plans they turned to the production of steam hammers. The first was a 15 cwt hand controlled hammer costing £150 and based on the original design drawn up by James Nasmyth.

The business prospered and large hammers were delivered to users in many parts of the world. The pneumatic hammer introduced at the beginning of the century proved a great success while about the same time the steam hammer had been improved by the addition of the Massey expansion gear valve and the Massey friction drop hammer had been developed.

This century so far has been one of continuous extension and progress. Many new designs have been developed; in the twenties these included double-acting drop hammers, solid frame and tiebolt type trimming presses, tyre fixing rolls and anvil block planing machines; after the Second World War came new high speed forging presses, use rollers and drop hammers. A number of companies were acquired and manufacturing of Massey hammers under licence began in Australia.

During its distinguished history the company has supplied a total of nearly 16,000 machines of various kinds, an achievement which well justifies the eminent position it holds today.

ROCK FASTENINGS.—The construction of the longest road tunnel in the world, from Entreves in Italy to Chamonix in France, seven miles in length, begun in the autumn of 1958, is progressing at the rate of 10 metres per day. Below the roadway an air current drawn by giant fans will ventilate the full length of the tunnel and tubing in the roof will extract stale air. To carry the ventilation and extraction tubes many thousands of Rawlplugs have been used. The Rawlplug Company have pioneered in this country the use of an expansion shield as the anchoring unit for roof holding

Manoeuvring Tank

A new £1,500,000 experimental manoeuvring tank, which will play a large part in developing the ships for the Royal Navy of the future, was officially opened on December 18 last, by H.R.H. The Duke of Edinburgh at the Admiralty Experiment Works, Haslar. For the first time in this country the ability of a warship to maintain speed and fight in rough weather can be studied on model scale in fully representative conditions by way of a novel wavemaking installation of unique design which can generate waves of any required height, length and pattern.

The manoeuvring tank is in a building overlooking Haslar Creek containing the main basin, 400-ft long by 200-ft wide, normally holding about 40,000 ton of water, and associated drawing offices, laboratories, workshops and store rooms. At one end and along half the length of one side are the great wedge shaped plungers, each 40-ft long, the finely controlled movement of which up and down in guide rails in response to signals fed into an electronic control system produces any required regular or

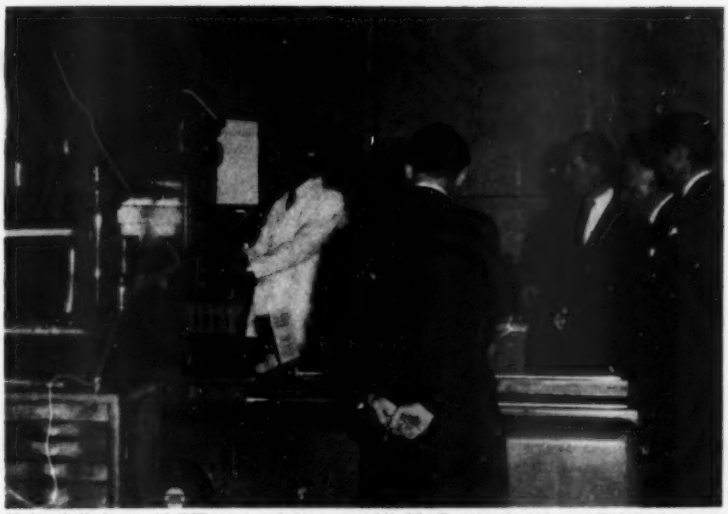
irregular wave pattern. Motive power for the hydraulic actuating gear is provided by electrical motors developing 880 hp. A tubular steel rotating arm about 100 ft long driven by a 500 hp motor with a Ward Leonard control, pivots at one end on a king post embedded in a concrete island in the basin and sweeps over the water. It can give speeds up to 32 knots to a 20 ft model attached to a carriage, equivalent to about 70 knots for a fast patrol boat 100 ft long.

From a raised control cabin the experimenter will regulate the speed of the rotating arm, the shaft revolutions of the model, and the movement of its control surfaces. Another raised cabin at the far end of the tank contains equipment to control the wavemaking plungers and the speed and course of free running models.

For this installation, Associated Electrical Industries Limited have supplied the 330 hp (500 peak horsepower) motor for driving the model ship towing arm, together with motor-generator set, contactor control and automatic electronic speed control equipment. The contract for this equipment was placed by the Ministry of Works.

Toolmaking on Merseyside

The new tool making factory of Whiteley Lang & Neill Limited, an amalgamation of Whiteley Mills Limited and Lang Precision Engineering Limited, two old established Merseyside engineering businesses, in association with James Neill & Co. (Sheffield) Limited, the parent company, famous for its Eclipse brand tools, was recently paid its first official visit by the Rt. Hon. Lord Mills, P.C., K.B.E., (Cabinet Minister without Portfolio) accompanied by the Lord Mayor of Liverpool (Ald. P. McKernan, J.P.), Sir Frederick Neill, C.B.E., D.S.O., T.D., D.L., J.P., and directors and senior executives from many North West industries.



7a Hydroptic jig borer with DIR memory device operated by Mr. R. Ashcroft at the new Whiteley Lang & Neill factory. Onlookers are, left to right, Mr. G. R. Beech (architect), Mr. E. Whiteley, (managing director) Lord Mills, and Mr. J. H. Neill (chairman).

The building of 46,494 sq ft overlooking Speke Airport, has a blazed wall 120 ft long × 14 ft high. Because of the excellent conditions within the factory certain departments normally enclosed, such as the jig boring bay are placed in an extension of the main shop.

The plant employs 184 people on contract toolmaking, with an ultimate 200 envisaged. Design and manufacture is undertaken on a large scale and a comprehensive punched card production control and costing system is used. Because of the many advanced machines used, there is a considerable volume of business in machining operations for the trade—especially jig grinding on Hauser 5SM machines (the largest jig grinding capacity available in this country), jig boring on machines up to GSIP 7A which have DIR fitted for the automatic reproduction of 40 positions in both coordinates, profile grinding by several different new techniques, copy turning, planing and milling and die-sinking up to 24 in. square × 60 in. long. Other interesting machines include Optimetric horizontal borers, full heat treatment facilities and also spark erosion machines—a process in which the company has specialized for some years.

The air conditioned and temperature controlled metrology department, used for pure measurement and for the routine checking of all shop measuring tools on a rota basis is equipped with a full range of high precision measuring tools including Talysurf and the only Trioptic measuring machine available in this country. This is capable of measuring almost any form within its capacity (max. job weight 3 cwt) to within a direct reading of 0·00005 in. and an estimate of 10 millionths of an inch.

The factory was built in 14 months from the starting date, the entire plant removal from the two old factories was completed in five weeks with little loss of production. The layout was planned before the building was designed and this was done with three-dimensional models largely in the company's apprentice school. Hardly any variation from plan was necessary on completion.

The apprenticeship ratio is about 5½:1 of total staff and the company keep a strict training syllabus including technical schooling.

General view of the new Whiteley Lang & Neill tool making factory

Preliminary Design of Gas Turbine Plant—I

This is the first of a series of articles presenting a full treatment of design procedure which will be accompanied by a completely worked example and all relevant data

By W. R. THOMSON, B.Sc. Tech.

1. Introduction and scope

The power engineer needs to be in a position to make a reasonably accurate comparison between the various forms of plant available, usually steam on the one hand and gas on the other, the word "turbine" being added in both cases when the job is of sufficient size.

Methods are therefore developed for designing, in outline, with a sufficient degree of accuracy, the components of a gas turbine plant, i.e.

(a) compressor
(b) turbine
(c) heat exchanger
(d) combustion chamber
(e) ducting.

From this knowledge of the component sizes the engineer will be able to draw out one or more arrangements of the plant from which to estimate weights and costs.

Attention will be restricted in this design to axial-flow compressors and turbines (i.e. to plants of large horsepower), to tubular counterflow heat exchangers, to straight-through combustion chambers with cylindrical flame-tubes, and to ducting of circular cross-section with vaned elbows.

An actual design case will be specified and the calculations for this case will follow each section of design.

2. Symbols, suffixes, and units

No attempt is made to follow any so-called "standard" symbols since such lists regard all symbols as being of equal importance. Here, those properties which are most often used in the design are given preference, i.e. given single-letter symbols without suffixes. Thus since specific heat at constant pressure is constantly in use, it is allotted the symbol k; whereas that at constant volume—little used here—carries its identifying suffix, thus k_v.

2.2. Symbols

A Area
F Stress
H Enthalpy or total heat
J Mechanical equivalent of heat (1400 ft lb per Chu)
L Length
M Mach number
N rpm
P Total head pressure
Q Mass flow
R Gas constant (96)
T Total head temperature
V Velocity
Z Modulus
a Pressure drop factor
c Chord length
d Diameter
f Stress
g Gravitational acceleration (32·2)
h Height
i Incidence angle
k Specific heat at constant pressure
l Length
p Pressure ratio (always > 1)
q Fuel-air ratio
r Radius
s Pitch length
t Temperature ratio (> 1) thickness
u Peripheral velocity
v Specific volume
w Width
α Air angle
β Blade angle
γ k/k_v
δ Deviation angle
ϵ Deflection angle
ζ Stagger angle
η Efficiency
θ Camber angle
ρ Density
σ Relative density
ϕ Stress factor
F_f, f_f Fluctuating stress
F_s, f_s Steady stress
f_b Bending stress
f_c Centrifugal stress
k_v Specific heat at constant volume
T_b Blade temperature
T_c Cooling air temperature
T_g Gas temperature
T_s Static temperature
V_a Axial velocity
M_a Mach No. of an axial velocity
P_s Static pressure
δT Total head temperature rise in a whole compressor
Total head temperature drop in a whole turbine
ΔT Total head temperature rise in a compressor stage
Total head temperature drop in a turbine stage
V_w Whirl velocity
ρ_s Static density

2.3. Suffixes

i	Inner
o	Outer
m	Mean
a	Axial
w	Whirl (or swirl)
ad	Adiabatic
x	Polytropic

Lengths	inches	in.
Areas	square inches	in.^{2}
Velocities	feet per second	fps
Rotational speeds	revs per minute	rpm
Enthalpy or total heat	centigrade heat units	Chu
Temperatures	degrees Kelvin	°K
Pressures	pounds per square inch	psi
Mass flows	pounds per second	lb/s
Densities	pounds per cubic foot	lb/ft^3
Specific volumes	cubic feet per pound	ft^3/lb
Stresses	tons per square inch	t/in.^{2}
Modulus	cubic inches	in.^{3}

3. The cycle (Fig. 1)

The continuous-flow Ramkine (or Brayton) constant pressure open cycle works between two temperature limits.

(i) the lower which is the ambient air temperature, and

(ii) the upper which is fixed by the materials of construction of those parts of the components which must withstand the temperature—notably the highly-stressed rotor blades of the turbine first stage.

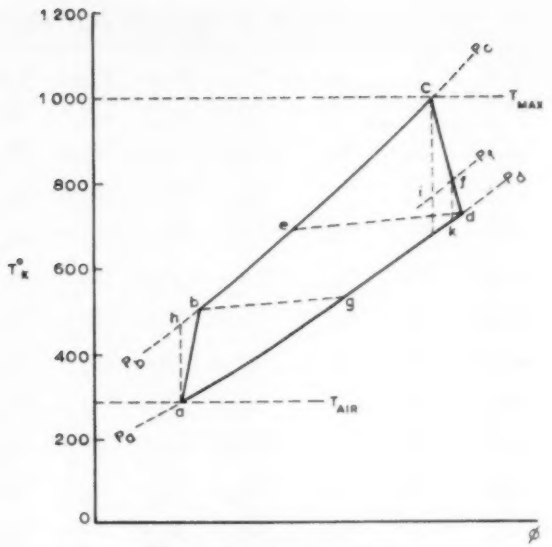


Fig 1.—The constant pressure cycle

The other main characteristic of the cycle is the compression pressure ratio.

In the more efficient form of the open cycle where heat exchange is employed the waste gases are enormously diluted and the cycle is almost a pure air cycle.

In the form of cycle illustrated in Fig. 1 the process

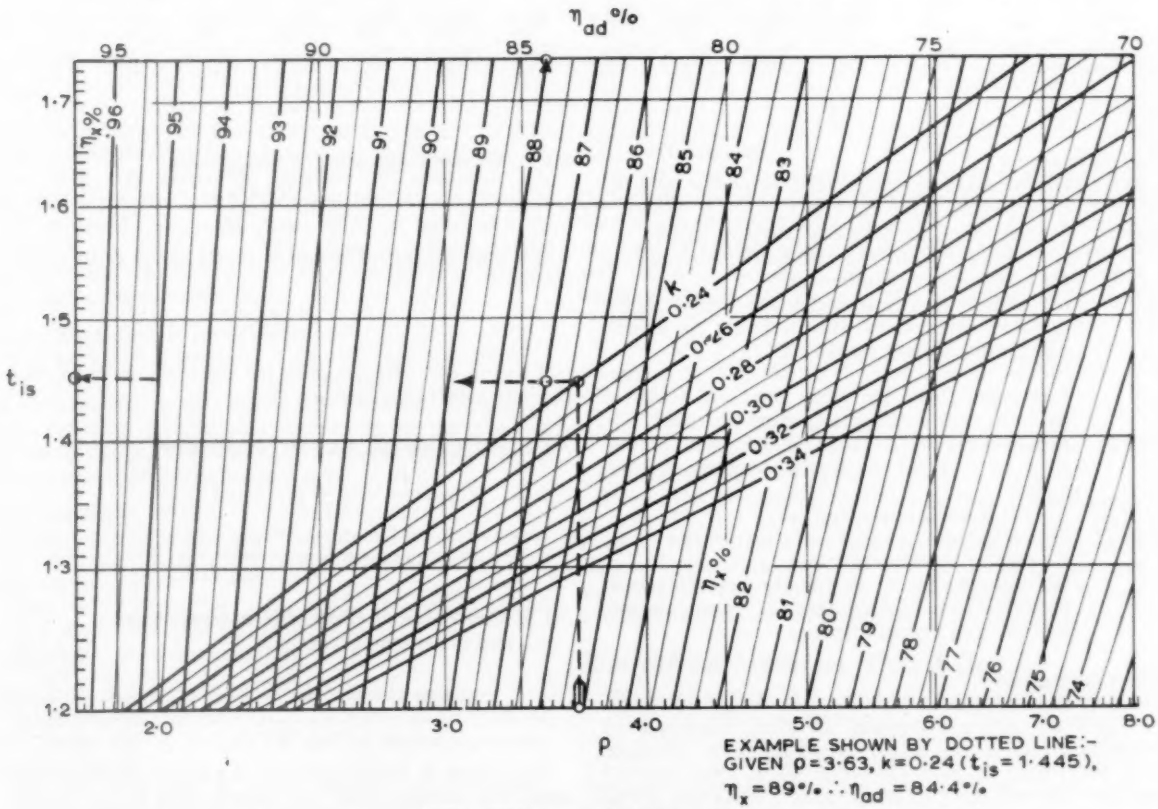


Fig 2.—Efficiency conversion in compression

Table I.—ENTHALPY OF AIR (H_{air}) AND GAS (H_{gas}), CHU PER LB WHERE $H_{gas} = H_{air} + \frac{q}{1+q}\theta_{gas}$

T °K		0	10	20	30	40	50	60	70	80	90	Av. Diff. for 10°
200	H_{air}	47·76	50·15	52·54	54·94	57·33	59·72	62·12	64·52	66·91	69·31	2·39
	θ_{gas}	16	18	19	21	22	24	25	27	29	31	2
300		71·70	74·10	76·50	78·90	81·31	83·71	86·12	88·53	90·94	93·36	2·41
		33	35	37	39	42	44	46	49	52	54	2
400		95·77	98·19	100·62	103·04	105·48	107·92	110·36	112·80	115·24	117·69	2·44
		57	60	62	65	68	71	74	77	80	83	3
500		120·14	122·60	125·07	127·54	130·02	132·50	134·99	137·47	139·97	142·48	2·48
		86	89	92	95	99	102	105	108	112	115	3
600		144·98	147·50	150·01	152·53	155·06	157·60	160·14	162·69	165·24	167·80	2·54
		119	122	126	129	133	136	140	143	147	151	4
700		170·36	172·93	175·51	178·09	180·67	183·27	185·87	188·47	191·08	193·70	2·60
		155	158	162	166	170	173	177	181	185	189	4
800		196·32	198·95	201·58	204·22	206·86	209·51	212·16	214·82	217·48	220·16	2·66
		193	197	201	205	210	214	218	222	226	230	4
900		222·83	225·51	228·19	230·88	233·57	236·27	238·97	241·68	244·40	247·12	2·70
		235	239	243	248	252	256	261	265	270	274	4
1000		249·84	252·57	255·30	258·04	260·78	263·53	266·28	269·03	271·79	274·55	2·75
		279	285	288	293	297	302	307	311	316	321	5
1100		277·32	280·09	282·86	285·64	288·42	291·21	294·00	296·79	299·59	302·39	2·78
		326	330	335	340	345	350	355	360	365	370	5
1200		305·19	308·00	310·82	313·63	316·45	319·27	322·09	324·92	327·76	330·59	2·82
		375	380	385	390	395	400	405	410	415	421	5
1300		333·42	336·26	339·10	341·95	344·80	347·65	350·51	353·37	356·23	359·09	2·85
		426	431	436	442	447	452	458	463	468	474	5
1400		361·95	364·82	367·69	370·56	373·44	376·32	379·20	382·08	384·97	387·86	2·88
		479	485	490	496	501	507	512	517	523	529	6
1500		390·75	393·64	396·54	399·44	402·34	405·24	408·14	411·05	413·96	416·87	2·90
		535	540	546	551	557	563	569	574	580	586	6
1600		419·79	422·71	425·63	428·55	431·47	434·39	437·32	440·24	443·17	446·11	2·93
		592	597	603	609	615	621	626	632	638	644	6
1700		449·04	451·98	454·92	457·86	460·80	463·75	466·69	469·64	472·59	475·54	2·95
		650	656	662	668	674	680	686	692	698	704	6
1800		478·49	481·44	484·40	487·36	490·32	493·28	496·25	499·21	502·18	505·15	2·96
		710	716	722	728	734	740	746	752	759	765	6
1900		508·12	511·09	514·06	517·04	520·01	522·99	525·97	528·95	531·93	534·91	2·98
		771	777	783	789	796	802	808	814	820	827	6
2000		537·89										
		833										

is as follows:

a to b: compression of atmospheric air in one or more compressors (here one only).

b to c: heat received at constant pressure, either
(i) entirely from the combustion of fuel in the combustion chamber, or
(ii) entirely in a heat exchanger from a source of heat external to the cycle as in atomic energy gas turbine plants, or
(iii) as shown here, from b to e in a heat exchanger from the cycle exhaust, followed by from e to c in a combustion chamber.

c to d: expansion in one or more turbines, here in two:
(i) c to f in the compressor-driving turbine, and
(ii) f to d in the power turbine.

d to a: heat rejected at constant pressure either
(i) entirely to atmosphere or
(ii) as here, from d to g in the heat exchanger to provide the heat referred to above, followed by from g to a to atmosphere.

3.1. Compression

The compressor works with less than perfect efficiency. In Fig. 1 the path *a h* indicates the ideal, isentropic, or adiabatic compression, whilst the actual path—idealized as a polytropic in path *ab*—must show some entropy increase. The efficiency of the process is described in two quite different ways, both essential in the cycle calculations.

3.1.1. Adiabatic efficiency in compression

$$\eta_{iad} = \frac{H_h - H_a}{H_b - H_a}$$

which may be approximated with negligible error to the usual

$$\eta_{iad} = \frac{T_h - T_a}{T_b - T_a}$$

This method of expressing the efficiency assumes that the path follows the lines *ah*, *hb*.

3.1.2. Polytropic efficiency in compression

$$p = \frac{P_b}{P_a} = \left(\frac{T_h}{T_a}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{T_b}{T_a}\right)^{\frac{\eta_{ix}\gamma}{\gamma-1}}$$

$$\text{whence } \eta_{ix} = \frac{\log T_h/T_a}{\log T_b/T_a}$$

3.1.3. Conversion of efficiencies in compression

η_{iad} and η_{ix} are connected thus:

$$\eta_{iad} = \frac{p^{\frac{\gamma-1}{\gamma}} - 1}{p^{\frac{\gamma-1}{\eta_{ix}\gamma}} - 1}$$

The graph in Fig. 2 converts one to the other for any case. The normal order of reading is p, k, η_{ix}, to give η_{iad} on the top scale and the example marked on the

Table II.—SPECIFIC HEAT AT CONSTANT PRESSURE OF AIR (k_{air}) AND GAS (k_{gas}) WHERE $k_{gas} = k_{air} + \frac{q}{1+q}\theta_{gas}$

T° K		0	10	20	30	40	50	60	70	80	90	Av. Diff. for 10°
200	k_{air}	·2393	·2393	·2393	·2393	·2393	·2394	·2394	·2395	·2396	·2397	·0001
	θ_{gas}	·126	·134	·143	·151	·160	·168	·176	·184	·192	·199	·007
300		·2398	·2400	·2401	·2403	·2405	·2407	·2409	·2411	·2414	·2416	·0002
		·207	·214	·220	·227	·233	·239	·245	·251	·257	·262	·006
400		·2419	·2422	·2426	·2429	·2432	·2436	·2440	·2444	·2448	·2453	·0004
		·267	·272	·277	·282	·286	·290	·294	·298	·302	·306	·004
500		·2458	·2463	·2468	·2473	·2478	·2483	·2488	·2494	·2499	·2505	·0005
		·310	·314	·317	·321	·324	·328	·331	·335	·338	·341	·003
600		·2510	·2515	·2521	·2527	·2532	·2538	·2544	·2549	·2555	·2561	·0006
		·344	·348	·351	·354	·357	·360	·363	·366	·368	·371	·003
700		·2567	·2572	·2578	·2584	·2590	·2595	·2601	·2607	·2612	·2618	·0006
		·374	·377	·380	·383	·386	·389	·391	·394	·397	·400	·003
800		·2624	·2629	·2635	·2640	·2646	·2651	·2656	·2661	·2666	·2672	·0005
		·402	·405	·408	·411	·413	·416	·418	·421	·424	·427	·003
900		·2677	·2682	·2687	·2692	·2697	·2701	·2706	·2711	·2716	·2720	·0005
		·429	·432	·434	·437	·439	·442	·444	·447	·350	·453	·002
1000		·2725	·2730	·2734	·2739	·2743	·2748	·2752	·2756	·2760	·2765	·0004
		·455	·458	·460	·463	·465	·468	·470	·473	·475	·478	·002
1100		·2769	·2773	·2777	·2780	·2784	·2788	·2792	·2795	·2799	·2802	·0004
		·480	·482	·484	·487	·489	·492	·494	·497	·499	·501	·002
1200		·2806	·2809	·2813	·2816	·2819	·2822	·2825	·2829	·2832	·2835	·0003
		·503	·506	·508	·510	·512	·514	·516	·519	·521	·523	·002
1300		·2838	·2841	·2844	·2847	·2850	·2853	·2855	·2858	·2861	·2864	·0003
		·525	·527	·529	·531	·533	·535	·537	·539	·541	·543	·002
1400		·2867	·2869	·2872	·2874	·2877	·2880	·2882	·2885	·2887	·2890	·0003
		·545	·547	·549	·551	·552	·554	·556	·558	·559	·561	·002
1500		·2892	·2895	·2897	·2899	·2901	·2904	·2906	·2908	·2911	·2913	·0002
		·563	·565	·566	·568	·570	·572	·573	·575	·576	·578	·002
1600		·2915	·2917	·2919	·2921	·2923	·2926	·2928	·2930	·2932	·2934	·0002
		·579	·581	·582	·584	585	·587	·588	·589	·590	·592	·001
1700		·2936	·2938	·2939	·2941	·2943	·2945	·2947	·2948	·2950	·2952	·0002
		·593	·595	·596	·597	·598	·600	·601	·602	·603	·605	·001
1800		·2954	·2956	·2958	·2959	·2961	·2963	·2964	·2966	·2968	·2969	·0002
		·606	·607	·608	·609	·610	·611	·612	·614	·615	·616	001
1900		·2971	·2972	·2974	·2975	·2977	·2979	·2980	·2982	·2983	·2985	·0001
		·617	·618	·619	·620	620	·621	·622	623	·624	·625	001
2000		·2986										
		·626										

graph shows that for the case where $p = 3{\cdot}63$, $k = 0{\cdot}24$, $\eta_{is} = 89\%$, the following results are obtained; t_{is} ($= T_b/T_a$ above) $= 1{\cdot}445$ if required, whilst $\eta_{iad} = 84{\cdot}4\%$.

If, however, η_{iad} were given and η_{is} required, say $p = 3{\cdot}63$, $k = 0{\cdot}24$, $\eta_{iad} = 90\%$, then t_{is} would remain as above and one would stop at $\eta_{iad} = 90\%$ on this t_{is} line, estimating η_{is} as $91{\cdot}7\%$.

3.1.4. Work done in compression

The work of compression $= H_b - H_a$ (per lb of air)
$= k\,(T_b - T_a)$

where k would be the mean value between T_a and T_b but normally it is sufficiently accurate to use the *true* k at the mean temperature $\frac{1}{2}(T_a + T_b)$ this then necessitating only one table of values for k.

3.1.5. Enthalpy of air

Table I gives the value of H_{air} directly at intervals of 10° C from 200°K to 2000° K and, of course, by interpolation to 1° C.

Thus for $T = 864°$ K, $H_{air} = 212{\cdot}16 + 0{\cdot}4 \times 2{\cdot}66 = 212{\cdot}16 + 1{\cdot}06 = 213{\cdot}22$ Chu per lb.

(See 3.4.5. for the meaning of θ_{gas}).

3.1.6. True specific heat of air at constant pressure

Table II gives the value of k_{air} directly at intervals of 10° C from 200° K to 2000° K and of course by interpolation to 1° C.

Thus for $T = 1387°$ K, $k_{air} = 0{\cdot}2861 + 0{\cdot}7 \times {\cdot}0003 = 0{\cdot}2863$. (See 3.4.6. for the meaning of θ_{gas}).

3.2. Heat exchange

In Fig. 1 it will be seen that heat is available from the exhaust gases between the two temperatures T_d and T_b. Thus heat available to the air $= H_d - H_b$. However, the heat exchanger works at less than perfect efficiency and the air can only take up heat between the two temperatures T_e and T_b where the efficiency of the heat exchanger is

$$\eta_i = \frac{H_e - H_b}{H_d - H_b} \text{ or with negligible error } = \frac{T_e - T_b}{T_d - T_b}$$

3.3. Combustion

Heat must be supplied by burning fuel in the flowing air to raise the temperature of the whole mass from T_e to T_c. Of course, in the process of combustion a much higher temperature than T_c will be attained and the materials of the chamber must be shielded (by cooler flowing air) from the effects of this. *To be continued.*

Russian Steam Turbine

A steam turbine with a capacity of up to 300,000 kW is being designed in Russia at the Urals engineering plant. Besides power generation it will be able to provide heating for a town with a population of several hundred thousand. Recently the plant completed the assembling of the country's largest 100,000 kW turbine.

Power Plant Preventive Maintenance

In this concluding article the author discusses preventive maintenance relating to miscellaneous items of electrical equipment and includes appendices of useful data

By SAMUEL LEES, Engineer Surveyor

Welding machines and condensers

Welders of a.c. single phase induction type are common today. Invariably of massive mechanical construction and simple electric design, and containing little moving mechanism they present no really difficult problems in maintenance. Working in somewhat forge-like conditions they are subject to excessive heat and are contaminated by much metallic dust and ordinary shop dirt.

With butt-welders the primary coils are the weak point, and require regular and frequent inspection and general overhaul, and occasional rewinds or renewals. Breakdowns are really inevitable under the severe working conditions of welding processes. For instance, coil insulants fail through excessive heat from overload, coil formers break, buckle, burn, and allow swarf and gritty dust to enter, blocking free ventilation, and by abrasion causing "earths" and short-circuits.

It is sometimes possible to improve an original coil by the use of stronger insulation on coil formers. For example, plain fibre formers were replaced by more robust formers made of mica, asbestos moulded to correct shape, instead of fabricating, and these stood up much better. A different type of winding with a new alloy improved both the working and longevity of a large butt-welder. Tapping switches should be inspected regularly and prompt attention given to necessary repairs.

Although strictly an electric machine, the two elements, primary and secondary, are sharply divided, the secondary, being for purpose of maintenance and repair, practically mechanical. Now, it may be interesting to observe whether or not the electrician should look after the whole apparatus, or should it be split up equally between the electrical and mechanical maintenance men?

A welder secondary certainly requires regular inspection and maintenance for worn and burnt clamp-jaws and attention to setting and pressing gear. The enormous currents dealt with call for good contacts since stray or vagabond currents may result in defective welds. Heavy abnormal load-peaks may occur through mishandling in the operating of the welder and cause the generator circuit-breaker to trip, resulting in a shut-down and consequent interruption of the weld. To guard against such eventualities it should be permissable to set the generator circuit-breaker so as to provide an appropriate time-limit on the dash-pot trip or other device, since such heavy welding peak-loads are necessarily intermittent and of short duration.

Happenings of this sort may have such undesirable repercussions on the maintenance engineer as costly spoiled stock, particularly when cut to fine weld limits and complaints from the production men about excessive rejects due to imperfect welds. Hence, efficient maintenance cannot be over-stressed.

It is a good plan to keep spare primary coils in stock since such details are not always of standard dimensions and require special jigs and formers and coil conductor. Unless the necessary tackle is available at a repair shop where similar coils have been made in the past, considerable delay may occur in the event of an individual coil having to be obtained from the makers of the broken-down welder in an urgent case.

Static condensers for power-factor correction, are invariably sealed before leaving the maker's works, and will be conspicuously marked on the tank name plate "not to be opened up under any circumstances". With the possible exception of switch-control gear, oil-gauges, alarm-signal devices, condensers give good service over long periods so long as the interior economy be not interfered with. Condensers have been known to go up in smoke without any previous warning, and in such cases it is almost a certainty that the only salvage will be the tank. Renewals of this class are probably better left to the makers.

The importance of strict attention to Regulations cannot be overstressed particularly Rule 21 on earthing. The same attention should be given to siting and location. Condensers should never be hidden away in some remote corner or inaccessible position just because such space happened to be available. The same procedure as with static transformers should be followed. The plain external design of a modern condenser or capacitor renders it easy for siting, and for economic reasons it will often be assembled to form part of the motor and switch-control units. Condensers and switch-control gear should never be fixed in a position where they may be subject to vibration.

Static transformers

The static power transformer is probably the most important member of an a.c. transmission system, and fortunately does not cause much trouble for the maintenance engineer. Considering the somewhat delicate interior economy of a transformer, this may seem somewhat remarkable, and yet in a way despite the fact that a work's eggs, if one may use the simile, are in a single basket, does not usually occasion undue worry.

Water in some form or other, is ever the great enemy of electricity. A large works was provided with several indoor sub-stations supplied by a municipal undertaking. One of the sub-stations housed three 2,000 kW 6600/3300/400 V. 3-phase transformers, all of a similar type, pipe, oil- air-cooled, fitted with top terminal connexions, and totally-enclosed, but not air-tight or sealed. These transformers had been in regular service for several years and had given no trouble whatever. But it so happened that an accident *outside* the building caused a heavy leakage from a near-by steam-main pipe, which had fractured, to overwhelm the sub-station. The live circuit-breakers operated promptly, the transformers were all soon saturated by water condensate, and this section of the works was completely shut down in consequence.

After the fractured steam-pipe had been isolated, an examination of the three transformers was made, and following a rough clean up and an insulation resistance test it was decided to switch in again. No. 1 circuit-breaker was closed and nothing amiss happened, then No. 2 was switched in quite satisfactorily, and the works' load gradually put on. The No. 3 circuit-breaker was now tried but refused to stay in and at this point a heavy flash was observed through the open terminal apparatus at the top of the transformer.

Owing to restricted space in the sub-station the No. 3 transformer was now disconnected and removed outside. The top cover was taken off and examination revealed the apparent cause. The present oil level was about one foot below the safe working level, and so the windings were exposed high and dry for that distance. The heavy flash observed was due to short-circuit affecting the whole top sections, and as far as could be judged visibly the three legs were badly damaged. The insulation was scorched and the copper bared in places.

The transformer was duly removed to the makers' works for necessary repairs. On opening out it was proved beyond question that the oil level had been below the working point for some considerable time judging by the film marking on the inside of the tank. Attention was now directed to the oil level gauge. This was of orthodox brass glass-tube type, and a cursory look warranted a closer examination. The inside of the glass tube showed a faint amber colour not unlike the transformer oil in the tank. The amber however, was only a thin dry pigment and the primary cause of the false level was in the angle-connexion screwed in the tank plate, which was completely gummed up. Apparently the false indication had been accepted, possibly when totting-up at maintenance periods.

In summing up, it was evident that the steam in considerable volume had entered the transformers through the terminal-lead openings, and so quickly saturated the exposed dry windings and bare connexions of the damaged No. 3 transformer. It would seem reasonable to deduce that the Nos. 1 and 2 transformers were not adversely affected because the whole of their windings was adequately submerged in the oil. Bearing in mind the fact that it requires but a minute quantity of water to seriously reduce the insulating value of transformer oil, it was decided later to treat the oil in both the Nos. 1 and 2 transformers by a centrifugal separator. In this connexion it may be of interest to note that opinion is somewhat divided as to the efficacy of filtering old oil, and that there is little to choose as regards cost between new oil and filtering. Further, although mechanical filtration may cleanse used oil of sludge and other foreign matter, it is ineffective in dealing with oil contaminated by acid formation. The testing of transformer oil is really a job for the laboratory. However, in cases where an oil is suspect much useful information may be gained by visual inspection of the transformer tank. Healthy oil has a clean smell. Contaminated oil will invariably have a disgreeable, sickly, acrid odour and a dirty brown look.

Transformer oil has a dual function, coolant and dielectric, and it is therefore, essential to maintain it in good condition. Deterioration is shown by the formation of "sludge" which may cause serious over-heating by preventing free ventilation. Hence, it is recommended by leading makers that transformers should be opened out, and if necessary, any sludge deposit recovered from windings and oil-ducts, if indicated after visual examination. The oil should be maintained at the correct gauge-mark, safe working level, and the tank topped-up if necessary. Apart from any serious fall in the oil level from extraneous causes, loss from evaporation seems to be almost invariably small. Oil-gauges should be kept in perfect working order to prevent possible false readings. It is a good routine plan to take samples of the coolant oil occasionally, especially if unusual heating is noticed on normal load conditions. Should there be cause for suspecting an oil, simple tests should be made for acidity, strength, and moisture crackle. In making a modified hot-wire crackle test it is well to take several samples from different points in the transformer tank. Sludge, if any, should *not* be disturbed. Should a work's plant be big enough to warrant it and there is cause for suspected contamination of transformer oil adequate samples of the oil should be submitted to the makers for fully comprehensive tests. It does not seem to be generally known that portable transformer oil-testing sets are available for works' use.

Appendices

USEFUL DATA
CURRENT AND POWER FACTOR

Direct Current Motors

$$\frac{\text{Brake horse-power} \times 746 \times 100}{\text{Voltage at Motor} \times \%\ \text{Eff.}} = \text{Current in Ampères}$$

Note: For a.c. Motors *Working* Current given by following formulae, the *total* current required will be greater than this, difference depending upon the Power Factor of Motor.

Single-Phase Motors

$$\frac{\text{Brake horse power} \times 746 \times 100}{\text{Voltage at Motor} \times \%\ \text{Eff.}} = \text{Working Current in Ampères}$$

Two-Phase Motors (4 wire)

$$\frac{\text{Brake horse power} \times 746 \times 100}{\text{Voltage at Motor} \times 2 \times \%\ \text{Eff.}} = \text{Working Current in Ampères per phase}$$

Three Phase Motors

$$\frac{\text{Brake horse power} \times 746 \times 100}{\text{Voltage at Motor} \times 1{\cdot}73 \times \%\ \text{Eff.}} = \text{Working Current in Ampères per phase}$$

Note: To obtain the *total* current the working current must be multiplied by:—

$$\frac{100}{\%\ \text{Power Factor}}$$

Current Values

Current in Ampères taken from LINE by an A.C. MOTOR

$$\text{2-Phase Motor. Ampères per Phase} = \frac{\text{B.H.P.} \times 373}{\text{P.F.} \times \text{Eff.} \times \text{Voltage}}$$

$$\text{3-Phase Motor. Ampères per Phase} = \frac{\text{B.H.P.} \times 430}{\text{P.F.} \times \text{Eff.} \times \text{Voltage}}$$

$$\text{Rotor Current. Ampères per Phase} = \frac{\text{B.HP.} \times 440}{\text{Rotor Volts between Slip Rings}}$$

Note: With Voltage applied to Stator the Rotor Volts are a maximum, when Rotor is stationary. At synchronous speed Rotor Volts are ZERO.

British Standards Institution Temperature Rise Figures

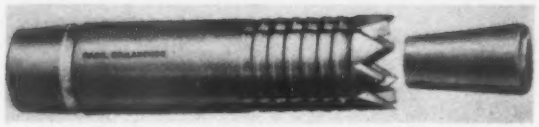
Types of Machines	All Windings and Cores in which windings are embedded	Commutators and Slip-Rings
Open, Protected, Encl. Vent with large mesh, and Pipe-Vent with forced draught	40 deg. C. 72 deg. F	45 deg. C. 81 deg. F.
Totally enclosed	50 deg. C. 90 deg. F.	55 deg. C. 99 deg. F.

PLANT PHILOSOPHY: SOME DON'TS

Don't attempt cleaning on live apparatus.
Don't forget, when the main supply fails, to make sure all the motor trips have acted.
Don't forget that starting switch trips may still hold on gradual shut-down.
Don't forget to open the isolator before handling a.c. high tension apparatus.
Don't make the mistake of thinking dead gear is always harmless; make sure by discharging.
Don't overlook oil dash-pots—they may fail to function in frosty weather.
Don't forget glycerine has a lower freezing point but is chemically unstable.
Don't forget all magnetic and thermal trip-gear is liable to fail; watch vigilantly.
Don't expose switch oil in a dusty or humid atmosphere.

Don't fill-up the oil-switch without first cleaning switch and cover-lid.
Don't forget to replace separators or barriers in the switch oil-tank.
Don't forget to replace the oil-filler plug, cap, or breather.
Don't re-use old contaminated oil; new oil is best and cheaper in the long run.
Don't trust implicitly static transformer oil level gauges; check by inspection or dip-stick; don't stir up sludge.
Don't believe that oil-gauges are infallible; disastrous breakdowns have followed a gummed-up oil-gauge.
Don't be rough in using a glass mercury thermometer in an oil-tank; a broken bulb may cause bad language and much overtime.
Don't forget that in a running machine the results of a broken mercury thermometer may be more immediate and illuminating.
Don't make a hasty decision and deduce wrongly on a zero insolution resistance test of a strange a.c. motor rotor; one slip-ring may be permanently earthed.
Don't omit, after testing or overhauling, to try out apparatus before reinstating in service.
Don't overlook the possibility that oil-soaked test-leads may cause an otherwise virtuous machine to seem guilty.
Don't fail to mark conspicuously all cable connexions, switches and fuses.
Don't hide cable connexions, section-boxes, links, fuses in inaccessible places; remember that emergencies call for prompt action.
Don't put excessive strain on terminal connexions, cable lugs and sockets; use cleats and secure anchorages.
Don't trust cable sweating lugs or sockets for heavy currents without substantial grub-screws.
Don't omit checking over plans for new cable runs; pencil lines on the drawing-board are easier to erase than cold cable or conduit—and cheaper too.
Don't depend on fuses for inaccessible a.c. three-phase motors; an open fuse may cause single phasing and result in a breakdown, and possibly fire.
Don't have underground cable runs level if survey tests indicate water percolation through the sub-soil.
Don't trust metal conduit for earthing continuity; get positive earth throughout the system.
Don't use ordinary insulating compounds for filling joint-boxes and the like in hot situations; tropical brands are best.
Don't poke around inside a power transformer until discharged dead.
Don't open out or expose to the atmosphere a sound oil-immersed power factor static condenser.
Don't mount a starting switch or capacitor on a motor subject to vibration.
Don't use a high-pressure insulator resistance ohmeter on a low-voltage apparatus, particularly on ancient lighting plants.
Don't risk bare metal spanners; use insulated box-keys where practicable.
Don't use metallized measuring tape near live apparatus.
Don't forget when skimming a commutator to set between lathe centres; when practicable, don't trust a jaw-chuck.
Don't forget to do all turning operations at one setting of lathe.
Don't forget to grind off set of saw-blade teeth (if used) before recessing inter-bar commutator micas.
Don't forget to rebed bushes correctly after reskimming commutator or slip-rings.
Don't jump an open-circuited armature coil indefinitely since it's only a temporary expedient.
Don't be sceptical; believe it or not, efficient ball-roller bearings have run for years on a single charge of lubricant.
Don't worry as to why machine makers now largely discard conventional grease-cups.
Don't force excess lubricant in ball-roller bearings.
Don't forget to raise oil-rings before withdrawing motor bearing bushes.
Don't depend on bearing oil-gauges; they're not infallible; keep them scrupulously clean or scrap them.
Don't allow oil-wells to get dirty; fibrous matter and dust cause oil to syphon out and a starved bearing may cause seizure and breakdown.
Don't expect a machine with adjustable end-shields to be cure for worn bearings.
Don't overlook the possibility that a worn shaft journal or bush may still show *constant* caliper measurement.
Don't forget to always check a doubtful bearing with plug or ring-gauge.
Don't trust absolutely air-gap measurements of a machine by feeler-gauge; check the lift of the driving shaft by hand or lever.
Don't use a crossed driving-belt; reverse the machine rotation.
Don't lubricate composition and fabric V-driving belts; avoid "bottoming"; keep them clean and dry.
Don't expose oil and grease lubricants to dust and wet; observe cleanliness in using.
Don't use fibrous waste for general cleaning; clean dry rag is best.
Don't use emery on shaft journals and bearings; abrasives generally are not good for bearings.
Don't use hybrid screw-threads where standard threads suit the job.
Don't run a slip-ring motor if the starting acceleration is erratic, examine starting switch; the cause likely is defective contactor resistance.
Don't neglect an unusual growl in a squirrel-cage motor; it is probably caused by a faulty fuse or starting switch.
Don't think a slip-ring motor just a "dead mass"; its live activity demands efficient short-circuit contacts and cables.
Don't forget to install only main switch-fuses of interlocking type.
Don't miss opportunities of watching riggers and slingers at work; you will pick up a tip or two; study lifting tackle, chains, ropes, knots and splicing.
Don't lift armatures and rotors by slinging direct on windings; use a cradle, woven loop or shaft; don't exceed an angle of 120° on a multiple sling—use a longer sling.
Don't confuse English tons (2240 lb) with U.S.A. (2000 lb) tons when using lifting tackle.
Don't neglect to keep a large-scale plan of your plant maintained up to date, showing location of all details.
Don't forget that you will be expected to be able to quote the Regulations and the I.E.E. wiring rules code backwards; make a close study of the articles of electricity regulations and memorize Regulation No. 21.
Don't be superior to using a standard wire-gauge; keep in practice with the micrometer caliper, and, yes, the slide-rule.
Don't be shy of consulting a good text book or of scanning connexion diagrams at your work.
Don't get in a rut; read your trade papers; qualify for entrance in a professional institution.
Don't forget: first-aid appliances are compulsory; keep a small private outfit at hand.
Don't tolerate dirty plant; statistics prove that dirt causes fifty per cent of electrical breakdowns.
Don't despise or belittle other tradesmen's ways and methods, or in your innocence conclude that a job is impossible, viewed your way.

Erratum. Line 31, p. 377 of our November, 1961, issue: for "motor" read "rotor".



The new Rawlplug Drilanchor is furnished with cutting teeth for making the hole and an expander for securing it in place

Self-drilling Bolt Anchor

The new Drilanchor made by The Rawlplug Company Limited, Rawlplug House, Cromwell Road, London SW7, is an improved cadmium-plated "self-drilling" shield of a type marketed for many years in America and suitable for applications where maximum strength of fixing is of less importance than speed of installation, or where hole-boring equipment is not available. Dependent on the nature of the masonry and the skill of the operator, it can, under ideal conditions, provide a strength of fixing approaching that of a Rawlbolt.

In operation the shield itself is used in the first place as a drill, either by (a) placing in a suitable holder and striking and rotating in the same way as with a Rawlplug tool, or (b) with the aid of a suitable adaptor in conjunction with an electric or pneumatic hammer. The cutting teeth alternate between chisel and pointed forms to facilitate rapid break-up of aggregate in the masonry. The debris is cleared by passing up through the anchor and the tool holder, and is ejected through the lateral holes. When the hole has been drilled to the correct depth the shield is withdrawn, and a hardened steel expander cone inserted into the toothed end of the shield. This is then hammered into the hole, thereby expanding the anchor and wedging the latter immovable in the hole. The expanding end of the anchor has saw-toothed ridges correctly shaped to provide maximum resistance to withdrawal under load.

Pneumatic Control Relay

An air-loaded precision relay has been added to the range of instruments produced by the Instrumentation Division of Associated Electrical Industries Limited, Crown House, Aldwych, WC2, for pneumatic control systems. Designated model 671A, it can be incorporated in any position in a control circuit where a varying air pressure is required to switch a separate air supply from one circuit to another.

These relays can be used as on/off controllers which operate at pre-set levels to initiate alarms or to operate air pressure-conscious electrical switches. Used with a double-acting air-operated changeover valve they will provide on/off control plus the facility of being able to adjust the change in the pressure (or differential) of the controlling air supply needed to operate the system.

The relay will operate over an ambient temperature range of −60° F to 180° F. Controlling pressure range is normally 3-15 psi but the relay will operate at up to 100 psi while the pressure of the air supply to be switched is a maximum of 100 psi. Variation of pressure required to operate the relay is less than 0·12 psi with a repeatability of within 0·03 psi.

Further Developments in Nickel

In two previous articles, current research into and developments in the use of nickel were outlined. It was indicated that the account was not complete. The present article carries it forward

DURING the last 30 years or so, the mechanism and prevention of intergranular corrosion in 18-8 austenitic chromium nickel stainless steels has been studied, but the shortage of nickel has caused metallurgists to turn their attention to the straight 18% chromium steels, to see if by some method these can be given freedom from the same form of attack. It has been known for some time that special heat-treatment can render the 18-8 steels immune to intercrystalline corrosion, and the question naturally arose whether the same remedy could apply to the 18% chromium steels. Particularly interesting was the fact that whereas a specific heat treatment might prevent corrosion in one steel, the same treatment might adversely affect another chromium nickel stainless steel of different composition.

It was found that 18% chromium steels with less than 2·5% nickel should be heat-treated in the same way as ferritic stainless steels, whereas those with more than 3·0% should be given the same heat treatment as the 18-8 steels. Alloyed nickel was found to be the direct cause of the difference in the response of the various austenitic stainless steels to specific heat treatments, and the variation from 2·5% to 3·0% nickel caused the transition from one type of response to the other. If work was cooled in the furnace within the transition range of 2·0% to 3·5% nickel after reaching a temperature of 1100° C, extreme intergranular attack was found. None of the steels showed intergranular corrosion when quenched in water from 760° C.

It is well-known that the valuable mechanical properties of steel used in large tonnages and steels of special kind are fundamentally dependent on the structures resulting from commercially practicable cooling rates. To provide the correct heat-treatment of a number of alloy deep-hardening steels both isothermal and cooling transformation curves have now been determined, and the specimens themselves later given a thorough optical and electron microscopic examination to reveal the structural details required for their mechanistic interpretation. It was found that although diffusion and interfacial energy effects are paramount at high temperatures and slow cooling rates, strain energy and nucleation site effects are dominant at lower temperatures and faster cooling rates. Globular alloy carbides precipitate at the edges of advancing pro-eutectoid-ferrite plates, and fine carbide rods precipitate within lower bainite needles in a multiplicity of directions suggestive of spontaneous shearing.

Temper brittleness has always been a source of worry, and it is interesting to note that during the last three years isoembrittlement diagrams have been produced for nickel steels. These clearly show that nickel alloy steels are susceptible to this form of embrittlement, but it is believed that plain nickel steels are not susceptible to it.

The influence of trace elements on the properties of nickel is of interest. The difficulty of preparing high purity nickel containing controlled additions without incurring crucible contamination and without using normal deoxidizers is responsible for the small amount of information available. Recently, melting in a controlled atmosphere and new techniques of casting have been developed for the preparation of nickel materials ideally suited for such an investigation. Differences observed for nickel-containing elements likely to form solid solutions are probably related mainly to degree of lattice distortion. For elements with extremely limited solubility an extra contributory factor is undoubtedly the character and degree of dispersion of the second phase. The data obtained appear to have indicated that the greater the increase in atomic diameter of the added element with respect to that of nickel, the higher the recrystallization temperature.

The compatibility of nickel with graphite has considerable interest in connexion with reactors. A study has been made of this and it appears to show that nickel is only slightly more reactive than copper, which is the least reactive metal of all those tested. Nickel is partly effective as a barrier for the diffusion of carbon into stainless steel. On the other hand, other researchers have shown that thermal cycling from a comparatively low temperature to 930° or 980° C results in deterioration of nickel by a graphitization mechanism, i.e., carbon goes into solution in nickel at the high temperature and precipitates in the form of graphite at the low temperature. The addition of copper to nickel notably reduces this graphitization by decreasing the solubility of carbon in nickel and, most important, by decreasing the rate of graphite precipitation from supersaturated solid solution.

Corrosion under stress causes cracking in austenitic stainless steels. The influence of nickel in this respect has recently been studied, and it has been suggested as a result that alloying additions of nickel above 8% in the presence of nitrogen delay cracking, but cracking is apparently inhibited only when the amount added approaches 50% or more. Although increased nickel both stabilizes the gamma phase and delays cracking, the results do not bear out the belief that a more stable phase 18-8 steel, whatever the stabilizing elements, would be more resistant to cracking.

Cracking of the stable gamma-phase pure 20% chromium 20% nickel alloys is associated mainly with nitrogen content. It is believed that a mechanism of stress corrosion cracking is based on strain-induced precipitates or incipient precipitates. Crack-sensitive paths are formed accordingly by the deformation process at the apex of the growing crack. The beneficial effect of nickel may be one of altering the pattern of cathodic atmospheres or precipitates, or of actually inhibiting their formation in the same way as nickel and silicon inhibit nucleation of cementite on the quenching of carbon steels.

The lowering of fracture strength by hydrogen is believed to involve the surface absorption of hydrogen

through the precipitation of hydrogen gas on a crack or lattice imperfection, which lowers the surface energy necessary for an extension of the crack. If this is true, additions of copper to nickel should initially increase the propensity to hydrogen embrittlement and then decrease it to zero. Tests have been carried out and it has been suggested that the dependency of hydrogen embrittlement on composition of the various alloys has been indicated. The embrittlement first increases, then decreases, with iron-nickel and nickel-copper alloys. The whole subject of hydrogen embrittlement, including these details, is admirably discussed in a paper, *The Role of Hydrogen*, by Alexander R. Troiano in the Transactions of the American Society for Metals, Vol. 52, 1960, p. 54.

The deformation properties and fracture properties of metals and alloys at elevated temperatures are affected by the character and behaviour of their grain boundaries. Fracture at high temperature propagates along the grain boundary. Work has recently been done with the idea of reducing the tendency towards intergranular fracture by using a directional structure with grain boundaries which are orientated parallel to the stress axis. The creep and rupture properties have been determined for a columnar grain cast structure in an alloy the strength of which is restricted by intergranular fracture when the grain structure is equiaxial. The alloy chosen for the research was a nickel chromium aluminium alloy containing 75·5% nickel, 21% chromium and 3·5% aluminium, which had previously been shown to have low tensile and rupture ductility and a tendency towards intercrystalline cracking. It was clearly shown that better strength and ductility at elevated temperature in this alloy could be obtained by producing a structure having columnar grains extending parallel to the applied stress. The rupture ductility was increased by a factor of 4 to 10 and the rupture strength by 15% to 20%.

Catastrophic failures as a result of brittleness continue to occur and some of these have involved large forgings. Experiments have recently been carried out to determine the effect of severe notches on brittle fracture behaviour such as exist in large steel sections and structure in the form of weld cracks, inclusions, flakes, contractional cracks, forging bursts, etc. The amount and kind of stresses necessary to initiate brittle failure in a large flat specimen containing a pre-existing cleavage crack were particularly investigated, using a nickel molybdenum vanadium forging steel. As a result, the complex character of flow and fracture phenomena have been further elucidated. It was found that the fracture strength in the presence of a pre-existing sharp crack is highly dependent on temperature, and exhibits a pronounced transition from well above to well below the normally measured yield strength over a narrow range of temperature. This transition is associated with a change in the mode of fracture initiation from a ductile shear tearing to a brittle cleavage fracture. Brittle fractures were obtained within the stress and temperature region where the type of steel tested is used in practice, so giving some insight into the possible causes of failure in service.

Geometrical conditions also govern the critical stresses and temperatures at which brittle fractures will start. Increasing the crack size in a constant section size decreases the fracture strength in proportion to the inverse square root of the length of the crack.

A recent development is the use of nickel or a nickel-base alloy as the binder metal in metal carbides other than tungsten carbide. These materials have been mainly developed as the components of jet engines for operation between 870° and 1200° C. Titanium carbide with a nickel binder is a typical example. Nickel or nickel base alloy is added to the extent of 30% to 70%. Such materials combine high resistance to oxidation, high hardness, resistance to thermal shock, comparatively low density and good creep rupture properties for the temperatures involved. The greater solid solubility of the carbide in the nickel alloy results in a binder phase of low ductility having notably lower impact values than tungsten carbide. These range from 1 to 12 ft lb. A second category of these materials contains the same base ingredients, but the binder content is usually below 20%.

Cast nickel is coming into increasing use and has a resistance to corrosion resembling that of wrought nickel. It is proving specially useful when applied to equipment handling corrosives such as caustics, and when it is essential to prevent a product from becoming contaminated with such metals as copper and iron. Resistance to galling under faulty lubrication can be provided by adjustment of the minor elements, including carbon.

A new nickel iron chromium copper alloy has been developed of recent years and is specially designed for the handling of corrosive liquids, particularly hot phosphoric acid and hot concentrated sulphuric acid. The comparatively high nickel content renders this alloy much more resistant to reducing conditions than most of the ordinary stainless steels. The chromium content is also valuable. The alloy has found useful application to a wide range of corrosives some involving mixed acids and mixtures of oxidizing and reducing agents.

A high nickel alloy containing 56% nickel, 22·5% chromium, 6·5% molybdenum and 6·5% copper is being developed and gives improved resistance to corrosion in a machinable high strength casting alloy. It is extensively used in dies for viscose cellophane extrusion and in pumps, valves and other process industry equipment where severely corrosive environments are met with. It is not usually recommended for halogen compounds but is highly resistant to sea water and to fluorine compounds in oxidizing environments. It has a tensile strength of about 30 ton/sq in., a yield strength of about 120 ton/sq in. and an elongation of 7·5% on 2 in.

Protective Coatings

The Bonderite '250' series of processes are designed to operate at room temperature and to produce on hot dipped galvanized steel, electro-zinc plated steel or zinc based alloys, chromate coatings which give considerable corrosion protection. The coatings also form surface for subsequent painting.

The range at present consists of three processes. Bonderite 250 is specifically formulated to produce a colourless coating with reasonable corrosion resistance, that would be particularly useful for preventing "white rusting" of articles during storage, and in other circumstances where a coloured film is considered undesirable. Bonderite 251 also produces colourless coatings but with improved corrosion resistance. When submitted to salt spray tests this process showed a considerable increase in corrosion resistance over other colourless chromate coatings. Bonderite 255 produces a heavier yellow coloured chromate film with the high corrosion resistance associated with coatings of this colour.

The series has been extensively tested and is now in full scale production by the Pyrene Company Limited, Great West, Road Brentford, Middx.

VOLTAGE CONTROL

D.C. Automatic Voltage Regulators

A number of external factors can affect the voltage of a d.c. generator and for precise control of voltage the most satisfactory method is by regulation of field current. Six ways of doing this are discussed

By J. L. WATTS, A.M.I.E.E.

POSSIBLE causes of reduced voltage of a d.c. dynamo or generator on load are reduced speed of prime mover, armature reaction, reduction of shunt field current due to reduced speed and terminal voltage, and resistive volt drop in the armature, series field and interpole windings. Whilst these effects may be roughly counteracted by suitable governing of the prime mover and generator design, the terminal voltage may also fall as the machine warms up due to increased resistance of the windings, especially of shunt field windings where increased resistance lowers the current. The resistance of copper increases by about 0·43% of its resistance at 0° C for each degree rise of temperature.

For precise control of the terminal voltage of a generator it is best to use an automatic regulator which monitors the voltage output, and adjusts the field current if the voltage differs from the required value by more than a certain amount, whatever the cause.

Motorized voltage regulator

One type of regulator incorporates a small motor to control a variable resistor in the shunt field circuit, as in Fig. 1. The motor is similar to a series d.c. motor, having an armature A, series field windings F and a resistor R which are connected across the generator. When the generator is at rest the shunt regulator is short circuited by the spring controlled contacts B until the regulator arm is moved to the full-field position, in which position the contacts are opened as shown.

When the dynamo is running at speed any increase of voltage above the value set by the resistor R_1 causes increased torque in the motor so that it turns against a spring to connect part of the shunt regulator into the shunt field circuit of the generator, the coil C then holding the contacts B open. Similarly, if the voltage falls the regulator cuts out some of the regulator resistance. The regulator shown has an additional winding G which is connected across the shunt S in the load circuit of the generator so that the current through G is proportional to the generator load current. The winding G is connected in magnetic opposition to F so that increased generator load has a similar effect to reduced generator voltage, causing regulator resistance to be cut out to increase the generator field current and voltage. In this way the generator voltage can be made to increase on increased load, if required, to compensate for volt drop on cables to a distant load point, giving an almost constant voltage at the load.

Carbon-pile voltage regulator

Fig. 2 shows the connexions of a comparatively

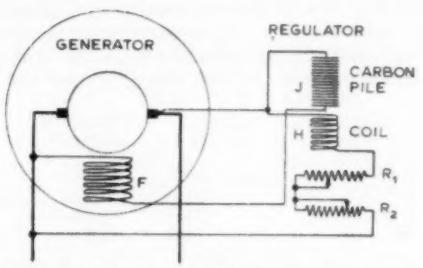


Fig. 2.—Connexions of a carbon-pile automatic voltage regulator

simple automatic voltage regulator in which the current in the field windings F of the generator is controlled by varying the pressure on a pile of carbon discs J in a ceramic tube. When no voltage is applied to the solenoid coil H the carbon discs are under pressure from springs, so that the pile has minimum resistance, to enable the dynamo to build up voltage when started up. As the dynamo voltage increases, the magnetism due to the coil H increases to reduce the pressure on the pile J and limit the dynamo field current. The coil H thus monitors the dynamo voltage to maintain this within limits. Temperature compensation is obtained by connecting the coil in series with the external resistor R_1, the resistance of which is practically independent of changing temperature, and by using bi-metal springs acting on the carbon

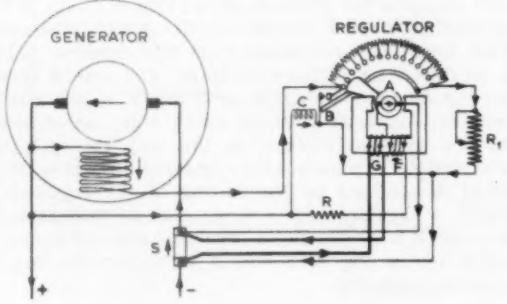
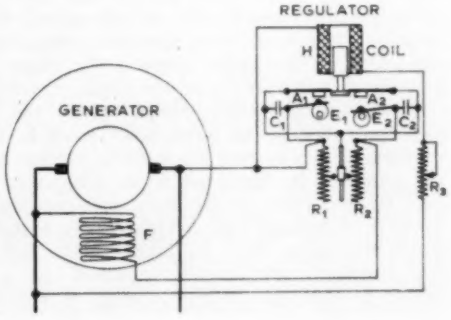


Fig. 1. (left)—Connexions of a motorized voltage regulator for a d.c. generator

Fig. 3 (right).—Arrangement of one type of automatic voltage regulator for a d.c. generator



pile. The speed of response of the regulator is of the order of 40 to 50 millisecond.

Power-driven vibrating-contact regulator

The basic arrangement of a regulator which is suitable for field currents of 1·5 to 5 amp is given in Fig. 3. The voltage output of the generator is monitored by the regulator coil H, which is fed from the dynamo terminals through the resistor R_3. Connected in series with the field windings F of the generator is the variable resistor having two sections R_1 and R_2, across which are connected the contacts A_1 and A_2, the lower contacts of which are vibrated by eccentrics E_1 and E_2 driven by the prime mover. The contacts thus move up and down at high speed when the generator is running. The upper contacts are carried on springs under the control of the plunger of the coil H. If the dynamo voltage falls, the coil H allows the top contacts to be slightly lowered, thus reducing the length of the periods during which the vibratory contacts open to connect R_1 and R_2 in the field circuit, and vice versa.

Compensated-voltage regulator for vehicle dynamos

The so called "constant-voltage" system of voltage control is used on most modern vehicle dynamos. As shown in Fig. 4 it employs a resistor F in series with the dynamo field winding, the resistor being short circuited by the spring-mounted contacts J when the dynamo speed and voltage are low. At low engine speeds the dynamo

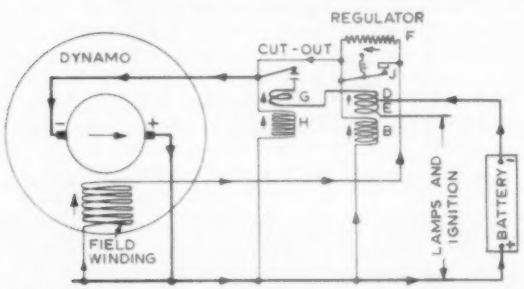


Fig. 4.—Connexions of a compensated voltage-controlled vehicle dynamo

voltage is too low to cause the coil H of the cut-out to close its contacts, and the coil B of the regulator is too weak to open J. As the engine speed and voltage rise the coil H closes the cut-out, and charging current through the series coil G helps to keep the cut-out contacts closed.

Further rise of dynamo voltage causes the coil B to open the contacts J to insert the resistor in the field circuit, when the reduced field current lowers the dynamo voltage. The coil B then releases the contacts J which short circuit F to raise the voltage again, this cycle being repeated continually at high speed. The vibrating contacts J thus control the dynamo voltage by automatically varying the ratio between the open and closed periods of J, depending on the engine speed mainly.

In the compensated voltage system the regulator is also controlled by the series coils D and E. The function of these coils is to limit the dynamo voltage by modifying the action of the shunt coil B, so as to avoid overheating the dynamo due to excessive load current, as might occur if the battery were completely discharged, especially if all the lights were switched on at the same time. The contacts are usually mounted on a bi-metallic spring so that the dynamo voltage is slightly increased during cold weather when the resistance of the battery may be more than normal.

Current-voltage control system

Two regulators are used in the current-voltage control system used on some motor vehicles. One regulator responds to the dynamo voltage, whilst the other responds to dynamo load current. With the dynamo running just above the cut-in speed the current through the current regulator is insufficient to open its contacts, so that the field circuit resistance is low because the current regulator contacts short circuit a resistor. As the engine speed and dynamo voltage increase, the charging current rises; the current regulator contacts then open and divert the field current through the resistor to limit the charging current. The contacts then reclose due to the reduced charging current and thus continue to vibrate at high speed.

The charging current is thus maintained at a constant value until the battery becomes charged to a certain voltage. The voltage regulator coil then opens its contacts and vibrates to maintain the voltage at a steady value, the charging current then gradually falling to a trickle just sufficient to make good the standby losses of the battery.

Control of large shunt dynamos

The basic circuit for another type of vibrating contact

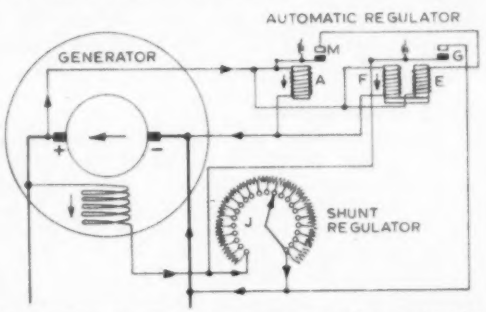


Fig. 5.—Connexions of a vibratory-contact automatic voltage regulator for a d.c. shunt generator

regulator is given in Fig. 5, and this is suitable for quite large shunt generators. On low voltage the contacts M are held closed by a spring, and the coils E and F of the relay are then both energized by the generator voltage. The magnetic effect of the coil E is in opposition to that of F so that, on low voltage, the total pull on the armature of the relay is insufficient to open the contacts G. Thus the regulator resistance J is short circuited by G.

If the dynamo voltage rises to a value slightly above that required, whether due to increased speed, reduced load or otherwise, the magnetic pull of the coil A becomes sufficient to open the contacts M so that the coil E is de-energized. The coil F is then able to open the contacts G which insert the resistance J in the dynamo field circuit to reduce the dynamo voltage. The coil A then releases the contacts M again, and coil E is energized to release G, J is short circuited again, with rise of field current and dynamo voltage. In this way the cycle is repeated rapidly to maintain the regulated voltage within the limits determined by the setting of the regulator. With such a regulator the voltage may be maintained within about 0·5%. The shunt regulator may, of course, be connected in the field circuit of either the main generator or its exciter.

Viscoidal Damping

The author considers that the resistance to motion of bodies attached to springs may be equal to or approach the value v^2 used in hydraulics, which he shows, gives a finite value for the time taken. This is the concluding part of an article based on a paper given by the author at McGill University, Montreal

By W. H. SHEPPARD, B.Sc.(Eng.)

Viscoidal Inertia Damping—General Case, Graph Series V

Let $\delta = P^{n/(n-1)}(At + B)$

where $P = d^{(n-1)/n} - [(n-1)/n](S/k)^{1/n}t$

$t = O,\ \delta = d,\ B = 1$

$\therefore \quad \delta = P^{n/(n-1)}(At + 1)$

and $v = [P^{n/(n-1)}(S/k)^{1/n}d^{(1-n)/n}]$
$-[(S/k)^{1/n}d^{(1-n)/n}t + 1]P^{1/(n-1)}(S/k)^{1/n}$
$= [(S/k)^{1/n}P^{1/(n-1)}]$
$\times [Pd^{(1-n)/n} - (S/k)^{1/n}d^{(1-n)/n}t - 1]$
$= [(S/k)^{1/n}P^{1/(n-1)}]$
$\times [1 - d^{(1-n)/n}(n-1)/n - (S/k)^{1/n}t$
$- (S/k)^{1/n}d^{(1-n)/n}t - 1]$

$\therefore \quad v = -[(2n-1)/n](S/k)^{2/n}d^{(1-n)/n}P^{1/(n-1)}t$

and $f = \{-[(2n-1)/n](S/k)^{2/n}d^{(1-n)/n}\}$
$\times \{P^{1/(n-1)} - t^{1/(n-1)}P^{(2-n)/(n-1)}[(n-1)/n]$
$(S/k)^{1/n}\}$
$= -\{[(2n-1)/n](S/k)^{2/n}d^{(1-n)/n}P^{(2-n)/(n-1)}\}$
$\times \{d^{(n-1)/n} - [(n-1)/n](S/k)^{1/n}t$
$-(1/n)(S/k)^{1/n}t\}$

$\therefore \quad f = -\{[(2n-1)/n](S/k)^{2/n}d^{(1-n)/n}\}$
$\times \{P^{(2-n)/(n-1)}[d^{(n-1)/n} - (S/k)^{1/n}t]\}$

$t = O,\ f = -[(2n-1)/n](S/k)^{2/n}d^{(2-n)/n}$

$v = O,\ t = O$ or $T = n/(n-1)(k/S)^{1/n}d^{(n-1)/n}$

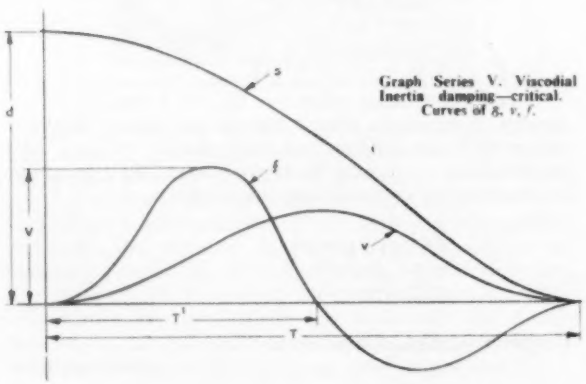
$f = O,\ t = T$ or $T^1 = (k/S)^{1/n}d^{(n-1)/n}$
$= [(n-1)/n]T$

It will be realized that to obtain the critical case the value of m must be adjusted to suit those of S and k. Equating values of f at $t = O$

$Sd/m = [(2n-1)/n](S/k)^{2/n}.\ d^{(n-1)/n}$

$m\ S^{(2-n)/n} = n/(2n-1).\ k^{2/n}.d^{1/n}$

$n = 2, \quad m = 2/3kd^{1/2}$ (not applicable to exact col^n)



Graph Series V. Viscodial Inertia damping—critical. Curves of δ, v, f.

$n = 3/2,\ mS^{1/2} = 3/4k^{4/3}.d^{2/3}$

$n = 1, \quad mS = k^2d$ (using exponent $mS = \frac{1}{2}k^2$)

Then δ, v and f may be determined in terms of S and m. These are more convenient, as d and $1/d$ are retained as a factor but it should be noted that altering d alters the relative values of S, m and k. The new equations are determined as follows:

$\delta = \{d^{(n-1)/n} - [(n-1)/n](S/k)^{1/n}t\}^{n/(n+1)}$
$\times \{(S/k)^{1/n}d^{(1-n)/n} + 1\}$

$\therefore \quad \delta = d\{1 + [n/(2n+1)]^{1/2}(S/m)^{1/2}t\}$
$\times \{1 - (n-1)/[n(2n-1)]^{1/2}(S/m)^{1/2}t\}^{n/(n-1)}$

$v = -\{[(2n-1)/n](S/k)^{2/n}d^{(1-n)/n}t\}$
$\times \{d^{(n-1)/n} - [(n-1)/n](S/k)^{1/n}t\}^{1/(n-1)}$

$\therefore \quad v = -(Sm/d)[1 - \{(n-1)/[n(2n-1)]^{1/2}\}$
$(S/m)^{1/2}t]^{1n/(n-1)}t$

$f = \{-[(2n-1)/n](S/m)^{2/n}d^{(1-n)/n}\}$
$\times \{d^{(n-1)/n} - [(n-1)/n](S/k)^{1/2}t\}^{(2-n)/(n-1)}$
$\times \{d^{(n-1)/n} - (S/k)^{1/n}t\}$

$\therefore \quad f = -\{(Sm/d)[1 - \{(n-1)/[n(2n-1)]^{1/2}$
$(S/m)^{1/2}t]^{(2-n)/(n-1)}\}$
$\times \{1 - [n/(2n-1)]^{1/2}(S/m)^{1/2}t\}$

$\delta = O,\ T = \{[n(2n-1)]\ m/[(n-1)S]\}^{1/2},\ v = O,\ f = O$

$v = O,\ t = O$ or $T,\ f = Sd/m$ or O

$f = O,\ t = T$ or $[(n-1)/n]T$

$\delta = O$ or $d\{1 + [(2n-1)/n]^{1/2}\}\{n^{n/(1-n)}\}$

$v = O$ or $V = -[(S/m)^{1/2}d(2n-1)^{1/2}]/[n^{(n+1)/(2n-2)}]$

Again it will be appreciated that these conditions are only obtained at the beginning and end of the motion for $n = 1$—2 exclusively.

If exact conditions are assumed for $f = O$ however,

$$mf + kv^n + S\delta = O$$

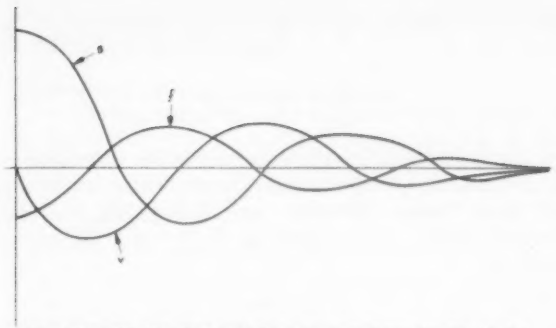
$\{O + [(2n-1)/n]^{n/2}m^{n/2}S^{(2-n)/2}d^{(1-n)(S/m)^{n/2}}\}$
$\times \{d^n(2n-1)^{n/2}/n^{n(n+2)/(2n-2)}\}$
$- Sd\{1 + [(2n-1)/n]^{1/2}\} \times \{n^{n/(1-n)}\} = O$

$(2n-1)^n/(n^{n/(n-1)}) = \{1 + [(2n-1)/n]^{1/2}\}/\{n^{n/(n-1)}\}$

$[(2n-1)/n]^n = 1 + [(2n-1)/n]^{1/2}$

$n = 1{\cdot}98$

or, remarkably, just short of where the general equation breaks down and it may be inferred that the equation for $n = 2$ is a good approximation. Graph Series III (Jan. *M.W.*) shows the curves plotted for $n = 1$, 3/2 and 2, with unit value for Sd/m. Value $n = 2$ does not apply exactly but intermediate values may be obtained by interpolation.



Graph Series VI. Viscoidal inertia damping—general case. Curves of δ, v, f

For $n=1$ the value $\delta = \epsilon^{-t}(t+1)$ is used. The same principle was then applied to the general case, i.e. vibrating (underdamped) and overdamped as follows:

Viscoidal Inertia Damping—General Case, Graph SeriesVI

$$\delta = P^{n/(n-1)} \times \{[A \sin qt + Bqt] \text{ or } [A \sinh qt + B \cosh qt]\}$$
$$x = o,\ S = d,\ B = 1$$
$$\delta = P^{n/(n-1)} \times \{[A \sin qt + \cos qt] \text{ or } [A \sinh qt + \cosh qt]\}$$

$$v = q\{P^{n/(n-1)}(A \cos qt \pm \sin qt) - (A \sin qt + \cos qt)(n/(n-1)(P^{1/(n-1)})(S/k)^{1/n}\}$$

$$x = O,\ v = O,\ O = dA - d^{1/n}(S/k)^{1/n},\quad A = d^{(1-n)/n}(S/k)^{1/n}$$

$$\delta = P^{n/(n-1)}(A \sin qt + \cos qt)$$
$$v = q\{P^{n/(n-1)}(A \cos qt \pm \sin qt) - (A \sin qt + \cos qt)(P^{1/(n-1)})(S/k)^{1/n}\}$$

$$f = q^2\{P^{n^2/(n-1)}(\pm \sin qt \pm \cos qt) - (A \cos t\, qt \pm \sin qt)^{n/(n-1)} \times (P^{1/(n-1)}) [(n-1)/n](S/k)^{1/n} - (S/k)^{1/n}[-(A \sin qt + \cos qt)^{1/(n-1)} (P^{(2-n)/(n-1)}) \times [(n-1)/n](S/k)^{1/n} + P^{1/(n-1)} (A \cos qt \pm \sin qt)\}$$

whence $Sd/m = q^2\{\pm d - Ad^{1/n}(S/k)^{1/n} - (S/k)^{1/n} \times [-(d/n)^{(2-n)/n}(S/k)^{1/n} + d^{1/n}A]\}$

$$S/m = q^2\{\pm d - d^{(1/n)-1}d^{1/n}(S/k)^{1/n} + d^{(2-n)/n}/n - (S/k)^{1/n}d^{(1/n)-1}(S/k)^{1/n}\}$$

$$= q^2\{\pm 1 - d^{(2/n)-1}(S/k)^{1/n} + (1/n)d^{(2/n)-2}(S/k)^{2/n} - (S/k)^{2/n}d^{(2/n)-2}\}$$

$$= q^2\{\pm 1 - d^{(2/n)-2}[1 - (1/n)(S/k)^{1/n} + 1](S/k)^{1/n}\}$$

$$\therefore \quad S/m = q^2\{\pm 1 + d^{(2/n)-2}(S/k)^{1/n}[(1/n)(S/k)^{1/n} - 2]\}$$

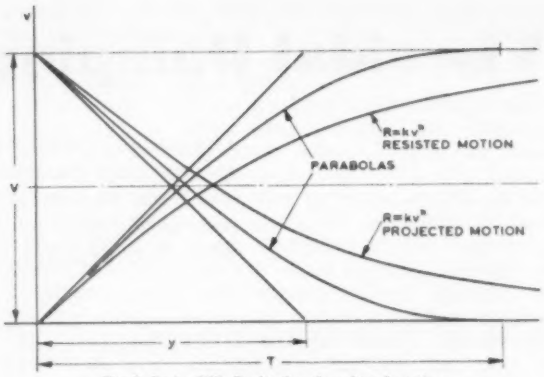
and $\tau = [n(n-1)]d^{n-1}(k/S)^{1/n}$

If value of $n = 2$ is considered, $m/k = \frac{1}{2}d$

$$\delta = d[1 + (2S/5m)^{1/2}t][1 - (S/6m)^{1/2}t]^3$$
$$v = -(Sm/d)[1 - (S/6m)^{1/2}t]t$$
$$f = -(Sm/d)[1 - (2S/3m)^{1/2}t]$$
$$f = O,\ \delta = O,\ T = (m/6S)^{1/2}$$
$$f = O,\ T = (3m/2S)^{1/2} = \tfrac{1}{2}\tau$$
$$m = \tfrac{3}{4}k^{2/3}S^{1/2}d^{2/3}$$

when $n = 3/2$

$$\delta = d[1 + \tfrac{1}{2}(3S/2m)^{1/2}t][1 - \tfrac{1}{2}(S/3m)^{1/2}t]^3$$
$$v = -(Sm/d)[1 - \tfrac{1}{2}(S/3m)^{1/2}t]^2$$
$$f = -(Sm/d)[1 - \tfrac{1}{2}(S/3m)^{1/2}t][1 - \tfrac{1}{2}(3S/m^{1/2}t]$$
$$\delta = O,\ t = (m/S)^{1/3}\,2\sqrt{3}$$



Graph Series VII. Resisted and projected motion

$$f = O,\ \tau = (m/S)^{1/3}.\ 2\sqrt{3} \text{ or } (m/S)^{1/3}.\ 2/\sqrt{3} = \tfrac{1}{2}\tau$$
$$\delta = d[1 + \tfrac{1}{2}\sqrt{3/2}.\ 2\sqrt{3}][1 - 1/(2\sqrt{3}).\ 2\sqrt{3}]^3$$
$$= d[1 + 1/\sqrt{2}][2/3]^3 = \tfrac{1}{2}d$$
$$V = -(Sm/d)[1 - 1/(2\sqrt{3}].\ 2/\sqrt{3})^2$$
$$= (4/9)(Sm/d)$$

Resisted Motion, Graph Series VII

In considering a body falling freely through a damping medium (Fig. 3) the cases $n = 1$ and $n = 2$ are capable of mathematical treatment and intermediate cases may

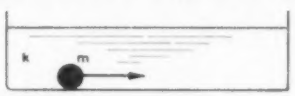


Fig. 3 (left).—Resisted motion. Fig. 4 (above).—Projected motion

be interpolated. Formulae are given below for reference and it will be noted that in both cases v is asymptotic to the terminal velocity V.

(i) $R = kv \quad W - kv = (W/g)f.$
$$\delta = (mg/k)(t + (m/k)\epsilon^{-(k/m)t} - m/g)$$
$$v = (mg/k)(1 - \epsilon^{-(k/m)t}) \quad V = mg/k$$
$$f = g\,\epsilon^{-(k/m)t}$$
$$\delta = (V/g)(V \log V/(V-v) - v)$$

(ii) $R = kv^2 \quad W - kv^2 = (W/g)f$
$$\delta = (V^2/g) \log \cosh gt/V$$
$$v = V \tanh gt/V \quad V^2 = mg/k$$
$$f = g \sec h^2 gt/V$$
$$V^2 = V^2(1 - \epsilon - (2g/V^2)S)$$

Since in both cases when t = O, f = g the graphs are directly comparable but it should be noted that the values of V are different. In both cases $\tau = V/g$. The velocity-time curve may be approximated by a parabola giving a result closer to actual conditions.

Then
$$\delta = (t^2/2)(1 - gt/6V)$$
$$v = t\,(1 - gt/4V) \quad V = 2\tau$$
$$f = 1 - gt/2V$$

Projected Motion, Graph Series VII

Considering a body projected in a viscous medium

(Fig. 4)

(i) $R = -kv$

$-kv = m\,dv/dt$

$dv/dt = -(k/m)v$

$\delta = e^{-(k/m)t} - 1$

$v = Ve^{-vt}$ where $V = -k/m$

$f = V^2 e^{vt} \quad \tau^1 = m/k$

(ii) $R = -kv^2$

$-kv^2 = m\,dv/dt$

$dt/dv = -(m/k)V^{-2}$

$t = (m/k)(V^{-1} + C)$

$t = O \quad v = V \quad C = -V^{-1}$

$t = (m/k)(v^{-1} - V^{-1})$

and $1/v = (k/m)t + 1/V$

$\delta = (m/k)[\log(k/m\,t + 1/v) + C^1]$ or $(m/k)[\log 1/v + C^1]$

$t = O, \quad S = O \quad C^1 = \log 1/V$

$\delta = (m/k)[\log(1 + t\,kv/m)]$ or $(m/k)[\log V/v]$

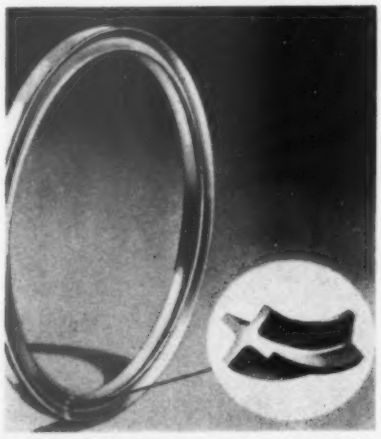
$f = -(k/m)(t\,k/m + 1/V)^{-2}$ or $-(k/m)v^2$

other cases, including the general case may be worked out similarly or more simply by interpolation, between $n = 1$ and $n = 2$. It will be observed that both the above curves for v are asymptotic to the terminal velocity but here again a parabola may be used as an approximation with $T = 2\tau$.

Ultra-light All-metal Seal

The BAR-X all-metal ring seals have numerous applications for hydraulic, pneumatic and hot gas systems in valves, actuators and fittings, providing that operating temperatures and pressures are within the general range of—455°F to +1200°F and 0—6000 psi respectively.

The range extends from ½ in. internal diameter to any size required, with standard seals up to 3 in. for static

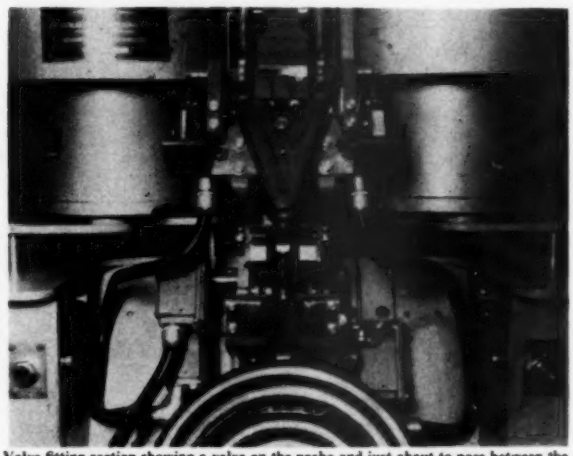


The BAR-X all metal seal is geometrically stable and unaffected by motion or pressure

applications and up to 2 in. for dynamic applications. The BAR-X, the makers state, is geometrically stable, being unaffected by direction of motion or pressure and is not sensitive to extreme changes of pressure, the same seal being equally suitable for both high and atmospheric pressures. In addition to remaining rigid under all dynamic conditions, it is unaffected by varied travel, is weather, salt-spray and fire-proof. Sole sales concessionaires in the United Kingdom and the Commonwealth are Aero Controls Limited, Weedon Road, Northampton.

Tyre Valve Inserting Machine

A semi-automatic tyre valve inserting machine has been supplied to Standard-Triumph International Limited, Coventry, by The Hymatic Engineering Company Limited, Redditch, Worcs. The machine will insert ½ in. and ⅜ in. valves which are placed separately into bowl feeders on the top of the machine. After being



Valve fitting section showing a valve on the probe and just about to pass between the soaping brushes. The spring-loaded clamp is in the open position

automatically sorted and orientated, the valves are fed into separate single tracks before finishing up at two escapements.

When a wheel is loaded on the inclined table at the front of the machine, it is turned radially until a spring-loaded plunger engages in the valve aperture. The depth to which the plunger sinks operates the appropriate escapement and allows a valve to be fed down to a pair of spring-loaded clamps. With the correct valve in the clamp, the foot valve is operated and a hinged arm, carrying a probe, swings over radially. The arm engages the valve on the end of the probe, opens the clamps, thus leaving the valve sticking to the end of the probe, lubricates the valve between two soapy brushes, supplied from a tank at the rear, and continues on its downward path to insert the valve in the valve aperture after first contacting the end of the valve selection plunger. When the foot valve is released, the arm swings back and the machine is ready for operating again. In case of possible stoppage or interruption, a special re-set button will swing the arm clear, close the clamps and make the equipment ready to start another cycle.

Five-way Connector Box

A five-way connector box for phase or neutral connexions has been added to the range of single-pole connector boxes produced by Associated Electrical Industries Limited, 145 Charing Cross Road, London WC2. List No. 43815, the box is suitable for conductors up to 0·06 sq in. Knockout diaphragms are at each cable entry, with two incoming diaphragms at the bottom of the box and three outgoing at the top. The connector block is of tinned brass with bell mouthed conductor entries and two brass pinching screws for each conductor. A clearance of ½ in. is provided between the knockouts and the connector block. The robust moulded case, dimensions 2¼ in. long × 3¾ in. wide × 1 7/16 in. deep, can be sealed if required.

Nuclear Energy: 1959–1960

A chronological survey of the principal events in research and development

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

1960

November (continued)

The contract for the £55 million atomic power station at Sizewell on the Suffolk coast was awarded to English Electric—Babcock and Wilcox—Taylor Woodrow Atomic Power Group. The two reactors are to be of the Calder Hall type with the net electrical output 580 MW and the installed generating capacity of 650 MW, consisting of two 325 MW sets. The station is scheduled for operation in 1966. Sizewell is C.E.G.B.'s seventh nuclear power station, will have the two reactors housed in one building, thus simplifying their control and economising in fuel handling equipment. The total net generating capacity in 1966 of nuclear power stations owned by the C.E.G.B. with Sizewell operating at full power would be 2766 MW and including Hunterston of the S.S.E.B., 3086 MW. For all nuclear power stations in Great Britain this total is 3366 MW(e). All the

Tab'e II.—ESSENTIAL PARTICULARS OF REACTORS, TURBO-GENERATOR SETS AND TURBINES OF NUCLEAR CONSTRUCTION IN GREAT BRITAIN

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
				Reactor			Turbogenerator sets				Conditions at t.st.v.				
											H.P.		L.P.		
No.	Nuclear Power station	Owners	Designer and manufacturer	No.	Total heat-rating	Heat-rating per reactor	No.	M.C. rating each set	Total gross gen. cap.	Total net output of station	press.	temp.	press.	temp.	Vacuum at turbine exhaust
					MW	MW		MW	MW	MW	psig	°F	psig	°F	in. Hg.
1	Calder Hall A and B (Cumberland)	U.K.A.E.A.	Nuclear Power Plant Co.	4	720	180	8	23	184	140	185	590	38	340	28·25
2	Chapel Cross A and B (Dumfrieshire)	U.K.A.E.A.	Nuclear Power Plant Co.	4	720	180	8	23	184	140	185	590	38	340	28·25
3	Berkeley (Gloucestershire)	C.E.G.B.	A.E.I.—John Thompson Nuclear Energy Co.	2	1100	550	4	83	332	275	295·3	604	49·3	596	29·1
4	Bradwell (Essex)	C.E.G.B.	Nuclear Power Plant Co.	2	1060	530	6	52 + 5%	389·1	300	730·3	700	180·3	700	28·9
5	Hunterston (Ayrshire)	S.S.G.B.	GEC—Simon-Carves Atomic Energy Group	2	1060	530	3 6	20·5 60	360	320	560	690	140	660	28·9
6	Hinkley Point (Somerset)	C.E.G.B.	English Electric—Babcock and Wilcox—Taylor Woodrow Atomic Power Group	2	1972	986	6	93·5	660	561	615	680	150	655	29·0
7	Trawsfynydd (Merioneth)	C.E.G.B.	Atomic Power Construction Ltd.	2	1740	870	3 4	33 145	580	500	927	715	290	685	—
8	Dungeness (Kent)	C.E.G.B.	Nuclear Power Group	2	1670	835	4	142·5	570	550	1395·3	738	535·3	736	28·9
9	Sizewell (Suffolk)	C.E.G.B.	English Electric—Babcock and Wilcox—Tavlor Woodrow Atomic Power Group	2	1900	950	2	325	650	580	677	732	268	732	29·0

Tab'e III.—ESSENTIAL PARTICULARS OF HEAT EXCHANGERS, REACTOR VESSELS AND CIRCULATORS OF UNDER CONSTRUCTION IN GREAT BRITAIN

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		Heat exchanger					Reactor vessel					Circulator						
No.	Nuclear Power station	Dia	Ht	Thick-ness	Total No.	No. per reactor	Shape	Dia	Ht	Thick-ness	Wht	Arrange-ment	Type of flow	Press. at dis-charge	Press. rise	Normal speed of circu-lator	Power of each circu-lator	Total power of circu-lator
		ft	ft	in.				ft	ft	in.	ton			psig	psi	rpm	bhp	bhp
1	Calder Hall A and B	17½	77½	1 1/16	16	8	cylin-drical	37	60	2		hori-zontal	radial	100·3	5·53/6·69	854/940	2055 (max)	16 440
2	Chapel Cross A and B	17½	77½	1 1/16	16	8	cylin-drical	37	60	2	—	hori-zontal	radial	100·3	5·53/·69	854/940	2055 (max)	16 440
3	Berkeley	17½	70	1⅛	16	8	cylin-drical	50	80	3	1 000	hori-zontal	axial	125	6·69	2900	3000	48 000
4	Bradwell	19	87	—	12	6	sphere	65½	—	3	1 100	hor-zontal	axial	130	—	2900	4400	52 800
5	Hunterston	20	80	—	16	8	sphere	70	—	2⅞	1 000	vertical	radial	150·5	7·5 max	1000	2190	35 040
6	Hinkley Point	21½	90	2⅛	12	6	sphere	67	—	3	1 700	hori-zontal	—	185	5·0	—	7000	84 000
7	Trawsfynydd	18	116	2½	12	6	sphere	61	—	3½	—	—	axial	240	—	2950	6000	72 000
8	Dungeness	23½	75	3½/4⅛	—	—	sphere	62½	—	4	—	—	—	268·3	—	—	9400	75 200
9	Sizewell	22½	91½	2½	8	4	sphere	63½	—	4	—	vertical	axial	264·3	11·09	2900	8700	69 600

reactors are of the Calder Hall type. A summary of the essential particulars of all nuclear power stations in Great Britain in operation and under construction are given in Tables II and III. The year of commissioning, the net generating capacity and the capital cost in £ per kW net are indicated in Table IV.

A symposium on nuclear ship propulsion, organised by the International Atomic Energy Agency, was held at Taormina, Sicily.

The Swedish State Power Board applied for Government approval to construct the 100 ME(e) nuclear power station at Marviken on the Baltic coast. This project was originally known as R4/Eve. The reactor is of the pressurised heavy water moderated and cooled type, using natural uranium as nuclear fuel, the thermal rating being 400 MW(th). It will be similar to the one at Agesta, near Stockholm, which has a thermal rating of 65 MW(th) and a net electrical output of 9 to 11 MW(e).

POWER STATIONS IN OPERATION AND UNDER

17	18	19	20	21	22	23	24	25
			Turbine					
Wetness at turb. exh.	final feed temp.	Speed	No. shafts	No. cyl.	No. Exh.	Steam quantity at turbine stop valve H.P.	Steam quantity at turbine stop valve L.P.	Station thermal effy.
%	°F	rpm				lb/hr	lb/hr	%
11	100·4	3 000	1	2	2	198 000	59 300	21·5
11	100·4	3 000	1	2	2	198 000	39 300	21·5
—	170	3 000	1	2	3	—	—	—
—	—	3 000	1	2	2	—	—	—
12·5	296	3 000	1	2	3	382 000	186 000	—
—	166	3 000	1	3	4	—	—	26·0
—	220	3 000	1	4	6	870 000	465 000	—
14·3	356	—	1	—	—	—	—	32·9
—	—	—	—	—	—	2 160 000	760 000	30·5

NUCLEAR POWER STATIONS IN OPERATION AND

20	21	22	23	24	25	26	27	28	29
				Circulator mass flow control system					
				Change in Speed					
Total No.	No. per reactor	Type of drive	Speed of motor	Speed range	Ward Leonard system	Mercury arc rectifier	Fluid coupling	Auxiliary steam turbines	Gas by-pass
			rpm						
8	4	d.c. motor	854/940	—	yes	—	—	—	—
8	4	d.c. motor	854/940	—	yes	—	—	—	—
16	8	a.c. motor	2900	5:1	—	—	yes	—	—
12	6	a.c. motor	—	—	—	—	—	yes	—
16	8	d.c. motor	1000	10:1	—	yes	—	—	—
12	6	a.c. motor	—	4:1	—	—	—	yes	—
12	6	a.c. motor	constant	—	—	—	—	—	yes
8	4	B.P. turbine	—	—	—	—	—	yes (B.P.T.)	—
8	4	a.c. motor	—	—	—	—	—	—	—

Tab'e IV

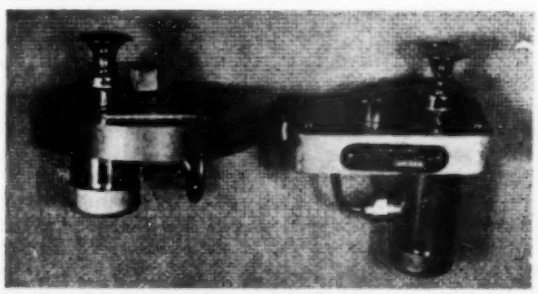
No.	Nuclear station	Year in commission	Net generating capacity MW	Cost in £ per net kW
1	Calder Gall (A & B)	1956/58	140	—
2	Chapel Cross (A & B)	1958/59	140	—
3	Berkeley	1961	275	160
4	Bradwell	1961	300	159
5	Hunterston	1961	320	—
6	Hinkley Point	1962	561	133
7	Trawsfynydd	1963	500	123
8	Dungeness	1964	550	110
9	Sizewell	1966	580	95

Although the capital cost per net kW generating capacity has decreased considerably from £160 for Berkeley to £95 for Sizewell, it is specially important to emphasize the cost of the latter is twice that of a conventional power station.

but will be above ground. Instead of using the pressure tube design it has been decided to have a pressure vessel.

The British Nuclear Energy Conference was held in London. A Symposium on "Steels for Reactor Pressure Circuits", was presented and discussed.

Work began at the nuclear research centre, Leopoldshafen, near Karlsruhe, on West Germany's second research reactor of the "Argonaut" type, with a rating of 10 watts. It was designed by Siemens-Schuckertwerke AG, Erlangen, Berlin for use in training and demonstration purposes. The cylindrical core contains aluminium—canned fuel elements and graphite moderator. The core is immersed in water and is surrounded by graphite reflectors and a radiation shield consisting of separate blocks of concrete. The reactor building is also cylindrical and is a welded steel shell, the interior being fully air conditioned. The main contractors for the complete installation are: Siemens-Schuckertwerke, Erlangen, Berlin; Lurgi Gesellschaft für Chemotechnik m.b.H, Frankfurt on Main; and Pintsch Bamag AG, Butzbach, Hessen.



The two new Tecalemit-Bijur hand operated lubricating pumps with circular and rectangular mounting flanges

Lubricating Pumps

Tecalemit (Engineering) Limited Plymouth, have added two hand-operated oil-pumps to the Tecalemit-Bijur lubricator range. Designed for sump-mounting on the machine to be lubricated, their flanges bolting to the machine surface, they are ideally suited for use on small lathes and small textile machinery. The pumps are of the spring discharge type, delivery being effected by raising the operating knob, which in turn raises the piston. When the knob is released, a spring pressure causes the automatic discharge of oil throughout the system.

Particulars for each are as follows *Pt. No. AH. 1532, Type LM Special:* piston stroke, $\frac{5}{16}$ in; mean discharge pressure,—50 psi; discharge volume per stroke,—0·565 cc; circular mounting flange,—3·125 in. dia; price, —£2 8s. 6d. net. *Pt. No. AH. 1533, Type LMH:* piston stroke,—$\frac{3}{8}$ in. (maximum); mean discharge pressure,—40 psi; discharge volume per stroke,—1·0 cc; rectangular mounting flange,—$2\frac{13}{16}$ in. × $1\frac{3}{8}$ in; price £2. 4s. 3d. net.

Production Practice:

Reducing Tubes on a Drilling Machine
Stellite Tip Spin Riveting Tool
Special Centre Punch

By JOHN WALLER

IMPROVIZATION is the keynote of jobbing work when a lengthy period often occurs between the times when articles of similar pattern arise; consequently purchasing a special machine and keeping it idle for so long is unthinkable, and efforts are continually being made either to adapt existing machines or provide equipment for them which will carry out the operation correctly. A typical case where this occured is illustrated in Fig. 1—a short tube which required one end to be reduced, an operation easily handled by a spinning lathe, but as it would have meant using a centre lathe for the work and using it continuously for several days each month, an alternative method was sought using a machine which was duplicated in that particular workshop, yet at the same time keeping the tooling simple.

While the tube length may restrict the application of this idea, the comparatively long adjustment available when raising and lowering a drilling machine worktable does allow some latitude, and provided the holding fixture is adequately ribbed to give the necessary support to a component standing a considerable height from the table surface, together with an arrangement to permit the assembly to swing clear from the drilling machine spindle and so make it easy to load the workpieces, then there is no reason why the full capacity of the table should not be utilized.

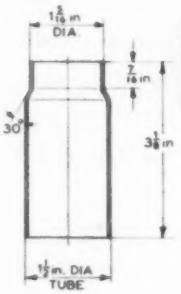
Fig. 2 illustrates a basically simple set-up, as the tube is merely inserted in a steel base A and clamped by pads B and C in the same way as the tools are attached to the turret of a capstan. A bridge strip D inserted in the block provides a stop and takes the thrust imparted by the upper tool as the tube is reduced in size. As dirt can collect in the bottom of this hole, a cross strip is preferable to using a disc which simply blocks off the holes and makes cleaning at the bottom a difficult operation. As copper is so soft, little wear takes place even after months of extensive usage, but a local case-hardening to the bore and pad faces is perhaps beneficial as this prevents pitting and subsequent damage to the tubes.

The upper tool locates in the spindle in the usual way by means of a taper, and as the weight is considerable a key or some similar fitting is essential to prevent it from falling out when the machine is at rest. Alternatively, the introduction of pillars of the type used in press tool construction is helpful especially when springs are included between the top and bottom members to hold them apart; if the pillars are made sufficiently long, it then becomes impossible for the top member to fall.

Three rollers E are set into holes bored in the holder F, and are made a close running fit in the bores to provide support and so overcome any tendency to deflexion. A simple spindle G which is shouldered in the conventional manner is used for securing them in position. These rollers conform to the shape of the tube and the leading edge is very slightly angled to give it the necessary lead and so make the initial introduction to the tubes easy. Hardening is essential and also a final smooth finish after grinding has removed the scale, with continuity outline.

A long reduction at the end of a tube means a lengthy roller which is naturally more prone to deflection than a shorter one, but this is occasionally overcome by increasing the diameter and so permitting the use of a bigger pin inside; thus there is a dual locating medium—the pin and recess machined in the holder.

A generous application of oil is needed before this



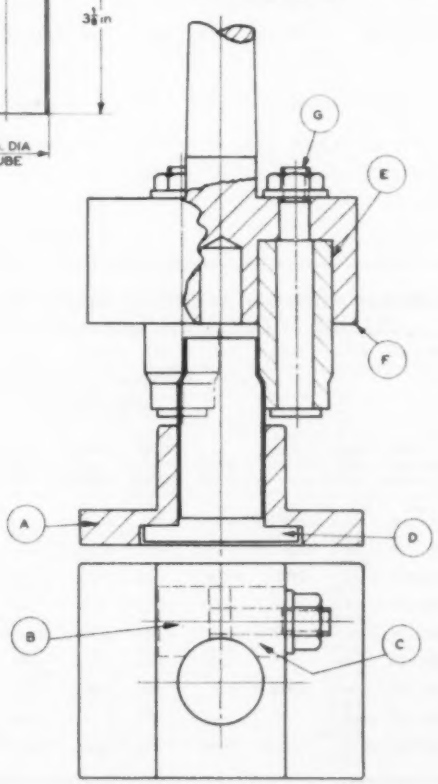
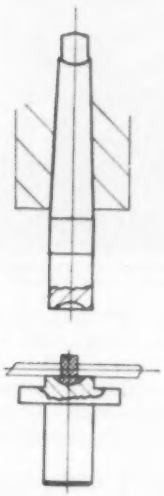


Fig. 1. (left)—Typical examples where tube reduction is short are often more quickly handled on a drilling machine than the orthodox spinning lathe. Fig. 2. (below)—Simplicity is a feature of this equipment but refinements such as pillars of press tool type and springs to assist release are useful additions

accessory commences to operate, and a slow downward movement is then applied to the drilling spindle until either a stop is reached. A fairly high speed is required to give the best results, but the actual number of revolutions is preferably adjusted in each particular case commencing with approximately 250 rpm as a minimum.



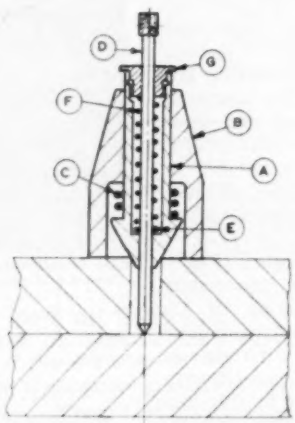


Fig. 3. (left)—Tool for spinning rivet heads. Fig. 4. (above)—Simplicity in locating is the keynote of this centre punch, coupled with equal ease in marking any component

In a small workshop some time ago the riveting together of several thousand sheet metal parts did not initially appear to create difficulties until it was appreciated that no suitable machine was available for closing over the heads of these rivets. It was thus decided to try and spin them over using a drilling machine. However, the first tools soon began to give trouble as the rivets were of a particular tough quality, and severe pitting and scoring of the tool meant that it was soon rendered useless for further work.

Remembering that Stellite was an efficient cutting material under awkward conditions, it was decided to try this material on the end of a short stalk. The cost of making such a tool was well within the usual experimental limit and it simply followed the lines shown in Fig. 3, the shank being turned with a taper to fit the machine spindle, and a small circular piece of Stellite being brazed on the opposite end. This end was eventually ground with a tiny cup wheel in order to produce a radius the same shape and depth as the rivet head, but care was exercized to see that the depression was also rotating concentrically with the taper shank of the tool.

When completed the tool was used on an old but still serviceable drilling machine which for this particular operation was provided with a motor to give a spindle rotation speed of about 4000 rpm. At this speed the rivet was seen to become red hot due to the friction between the pieces and to then spin over to the required shape, the operation taking about ten seconds to complete. One feature was the tightness of the rivets when they cooled, which more than compensated for the slight discolouration of the metal due to the heat.

While the rivets in question were $\frac{1}{8}$ in., it is felt that this tool will successfully spin over larger diameters than this, the limiting factor evidently being the size of machine available and whether the pressure could be imparted by the automatic feed without damaging the machine bearings.

The transferring of hole centre distances from one plate to another is seldom regarded as difficult and the time honoured method is simply to drill through the mating plate once the assembly is correctly aligned, but just occasionally an instance arises where departure from the accepted practice is necessary, and instead of spotting through with a drill, a centre punch is easier.

This can occur when reamed holes are made in the upper plate and passing a drilling through them is almost sure to cause trouble; thus a specially designed centre punch is an asset. As shown in Fig. 4, after initially centring the punch by means of the cone A, the body B is pressed down on the top surface of the upper plate. This causes the spring C to compress and exert pressure on the cone and so keep it firmly and centrally in the hole. The punch D is withdrawn a short distance and released so that it drops sharply under the action of spring F and so marks the sheet with the hardened point.

Some attention to the question of fits is essential with this assembly. Too tight a fit of the punch can cause stickiness and interfere with the action. A washer brazed to the punch provides a surface against which the spring can bear, and also a stop face to prevent the punch from falling out of the inner sleeve. A threaded retaining cap is preferable to one simply pushed into the sleeve as it is easier to dismantle when repair is necessary. A heavily knurled rim is generally sufficient for its removal.

All parts require hardening—silver steel hardened throughout is ideal for the punch, but the outer and inner sleeves are preferably casehardened as this leaves a tough core which can resist chipping and fracturing.

Commutator Undercutting

Automatic machines, installed at Hoover Limited's Perivale plant by EMI Electronics Limited, Hayes, Middlesex, are being used to undercut commutators for a range of universal armatures used in vacuum cleaners and electric floor polishers. One operator controls three of the machines and another operator besides working an undercutting machine also completes rough and finished turning on two lathes during the automatic undercutting cycle. The armature is held in a quick release collet. A photo-electric servo system controls the selection and cutting of each slot in turn, at a rate of up to one slot per second and to an accuracy of $\pm$ 0·002 in. at the periphery of the commutator. The machine will undercut from 9 to 125 segments per commutator.

Panel Saw

A heavy duty panel sawing machine model E.U., supplied by Thomas White & Sons Limited, of Paisley, to the Wilton Plastics Division of Imperial Chemical Industries Limited, for use in sizing "Perspex" sheet, retains the principle that, for greatest accuracy and quality of cut, panels must be stationary during the cutting operation. The saw head traverses the sheet automatically, eliminating the manual feed necessary with a bandsaw. The machine is supplied as a self-contained unit for trimming single panels, high density panels and thin panels in multiples, including plastic laminates. Maximum width of panel accommodated is 16 ft and maximum thickness of one or multiple panels is three inches. Panels may be any length, as required.

Machine Tool Record

Tape-controlled Programme Milling

The advantages of programme control on milling machines are that change-over times are substantially curtailed and one-off and very small series production can be made profitable, and that the setting-up of the machine is largely absorbed in production planning, so the machine produces more and it is impossible for the operator to interfere with the prescribed feed rates in order to obtain shorter machining times which might react unfavourably on the life of the cutters and the machine.

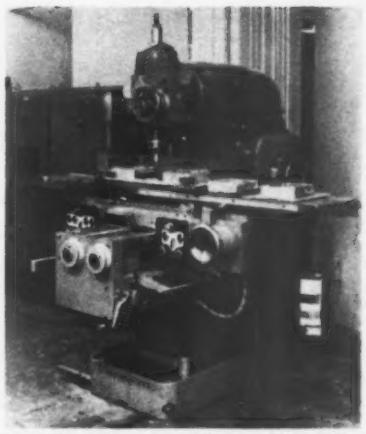
How these advantages are secured in the Fritz Werner knee type milling machine was demonstrated recently by The Rockwell Machine Tool Company Limited at their showroom at Welsh Harp, London NW2. The machine is provided with a high precision rack for each movement direction, and meshing with this is a play-free pinion which drives the synchro system which generates a voltage corresponding to the position of the table at any time. This is reported as a varying voltage to the control cabinet and compared there with the input data. The moment the two values coincide, a relay operates to bring the table to a standstill.

The punched tape carries the programme commands for all the movements. The coding and reading are done line by line by photo-cell scanning, and the values obtained are fed to a memory unit which retains the information until the machine has carried out the required movement and the table has stopped at the position ordered. A five-channel telex code is used in which three holes are punched at a time, thus giving ten possibilities so that the 10 digits 0 to 9, which are necessary for determining the travel of the table in the form of a decimal figure, can be completely expressed.

The programme "word" is compiled of functional information and distance information. The functional information consists of the commands which cause certain circuitry to become operative, i.e. spindle on, spindle off, feed on, feed off, etc. Distance information consists of the co-ordinate dimensions.

In the input data sequence (Fig. 1) the first line contains information required for the function of the spindle. The second and third lines contain functional information determining the feed or rapid traverse. Two lines are required in this case as there are more than 10 feeds to be programmed, namely 16. In addition there are the zero feed (0) and the rapid traverse. Since only one of these lines needs to be programmed, provision is made for bridging one of them by means of the "continuation" letter. In the fourth line, the required co-ordinate direction is selected, i.e. longitudinal, transverse or vertical, and provision is made for selecting these movements "with" or "without" brake. In addition, there is a code number for "table check", which permits the position of the table to be checked by measuring.

In lines 5 to 9 the co-ordinate dimensions are entered, from the fifth line which represents hundreds of millimeteres to the 9th line which represents hundreds of millimetres. At the end of the word, the tenth and eleventh lines are for the teleprinter carriage return and line advance. In the example in Fig. 2 the lines follow vertically from right to left. The word itself is "JYWBBFWYM<≡", and its meaning is spindle clockwise—rapid traverse—longitudinal table travel with brake, co-ordinate dimension 643·50 mm (see Fig. 3).



Fritz Werner knee type milling machine. Cabinet houses programmed automatic control equipment

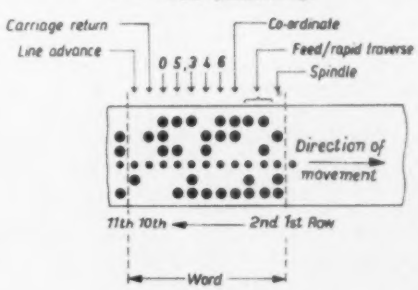
When the complete word has been read by the machine, the operating command is automatically given to set the table in motion. At the same time the voltage corresponding to the position of the table is continuously compared with the data fed to the memory unit and the table is brought to a standstill when the two coincide. The tape then advances to the next word which is read for the next programme step.

In order to prepare a tape, a programming table is made (Fig. 3). After entering the general data concerning the workpiece cutter and machine, the change-over points are ascertained step by step by using the dimensions of the workpiece as given on the drawing. After having entered the data for lines 1 to 4, an intermediate calculation is made taking into consideration the co-ordinate dimension to the change-over point and the overrun allowance. A plus or minus sign will appear

Row	Command		Code
1	Spindle	↷	J
		↶	F
		Off	U
		Tool change	W
2	Feed mm/min	0	W
		31,5	B
		40	C
		50	F
		63	G
		80	J
		100	M
		125	P
		160	U
		Continuation	Y
3	Feed mm/min	200	B
		250	C
		315	F
		400	G
		500	J
		630	M
		800	P
		1000	U
		Rapid traverse	W
		Continuation	Y

Row	Command		Code
4	Longitudinal	with brake	B
		without brake	C
		check table	U
	Transverse	with brake	F
		without brake	G
		check table	W
	Vertical	with brake	J
		without brake	M
		check table	Y
5 to 9	Dimension	0	M
		1	U
		2	J
		3	W
		4	F
		5	Y
		6	B
		7	C
		8	P
		9	G
10	Carriage return		<
11	Line advance		≡

Fig. 1. (left)—Sequence of input data. Fig. 2. (below)—"Word" punched in tape



here, according to whether the movement of the table is towards the zero point or away from it. With this machine, the zero position of the table is at the extreme left, front and bottom. The final co-ordinate dimension is entered in columns 5 to 9 and the entire word is formed of the letters as taken from Fig. 1. The heavily outlined box, Fig. 3, is now converted to tape language by a teleprinter, the printed slip obtained being comp^red once more with the layout table as a final check.

Punched Tape Control Programme

Machine : FV 2D	Customer :	Order No :
Workpiece : Switchbox	Cutter = End mill 2" diam	Spindle speed : 1800 rpm
Dwg. No. / Part No.	Tooth material : Carbide TH 10	Feed : 31 ipm (800 mm/min)
Material : Alu 225	No. of teeth : 4	

	Rows 1	2	3	4	5 6 7 8 9	1 2 3 4 5 6 7 8 9 10 11		
Prog. Stage	Spindle direction	Feed mm/min	Feed mm/min	Co-ord. direction	Co-ordinate dimensions	Tape Word	Allowance as per table	Corrected input figure
1	⌒	—	Rapid	longt.	0 4 3,5 0	J Y W 8 8 F W Y M < ≡	– 11,5 0	0 5 5,0 0
2	⌒	—	315	longt.	0 5 8,1 0	J Y F 8 8 Y 8 U M < ≡	– 0,8 0	0 5 7,0 0
3	⌒	—	Rapid	vert.	3 7 0,2 0	J Y W J W C P J M < ≡	– 2,3 0	3 0 0,5 0
4	⌒	31,5	—	vert.	3 0 2,4 0	J U Y J W P J F M < ≡	– 0,1 0	3 0 2,5 0
5	⌒	—	800	transv.	1 2 4,3 0	J Y P 6 U J F W M < ≡	+ 2,3 0	1 2 2,0 0
6								
7								
8								
9								
10								

Fig. 3.—Programming Table

Tactile Finishing Standards

Rubert & Co. Limited, Demmings Road, Cheadle, Cheshire, who have produced machining scales to British Standard specification for many years, have now brought out a complete range of electro-formed surface standards which conform to the British Standard specification in every respect, and are reasonably priced due to a new electro-forming technique developed over the last two years. The complete range consists of twelve different scales representing every standardized finish obtainable by the twelve basic machining methods: flat specimens; parallel and criss-cross lapping, grinding, linishing, end milling, face turning, shaping, planing, horizontal milling: cylindrical specimens; lapping and superfinishing, diamond turning, grinding, turning, reaming and drilling.

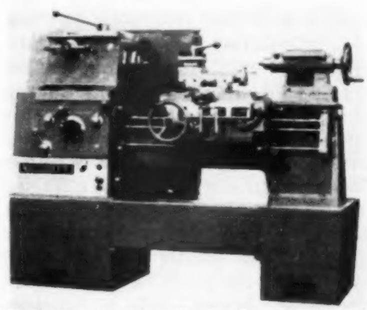
Each scale is separately framed in a moulded plastic casing showing the respective value for CLA in micro inches and microns on the front, whilst a short description of the most characteristic features and special instructions on how to obtain the best comparison results for that particular machining method, as well as a table giving the values for maximal depth and levelling or mean depth for each specimen, is moulded on the back. To avoid mistakes in comparing different machining methods each scale is clearly marked and in addition each machining method is represented by a different colour to avoid even the possibility of a wrong scale being issued.

The 12 scales can be supplied in one box. Each scale can also be supplied singly or in any combination from two upwards. With these 12 scales over 4,000 different sets can be made up. Each scale is easily removable from the wooden box. With this new system sets can be made "to measure" to their particular requirements at prices based on mass production. The price £5 10s. per scale.

Left, complete set containing all twelve colour coded scales. Below, turner using a scale

High Speed Lathe

The new Elliott M-series lathe, has an exceptionally wide range of spindle speeds. The usual technical difficulty of excessive noise from gearing is overcome in the new "omnispeed" headstock by transmitting the drive to the spindle in the four highest speeds (705 to 2500 rpm) by timing belts, leaving the gearing to deal with the remaining eight speeds and to transmit the higher torque required in the lower range. Even with the spindle turning at 2500 rpm the maximum gear meshing speed, however, is less than 700 ft/min. All twelve speeds are lever selected. Another feature is that when the high spindle speed range is selected the feed drive to the change gears is automatically reduced in the ratio of 4:1 to prevent accidental overspeeding. Due to the absence of small diameter high speed gears the hollow spindle has a capacity of 2 in. dia.



Elliott M-series lathe with new "omnispeed" headstock

The rest of the machine shows full attention to "follow-through" to match up with this new high performance headstock. The apron, for instance, is of double-wall totally enclosed design, the bearing housing is oil cooled, a foot pedal is provided to brake the spindle, the switch gear is fitted in one removable unit under the headstock, and a full range of accessories is available, including taper turning and hydraulic copying.—B. Elliott (Machinery) Limited, Victoria Road, London.

technique

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Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

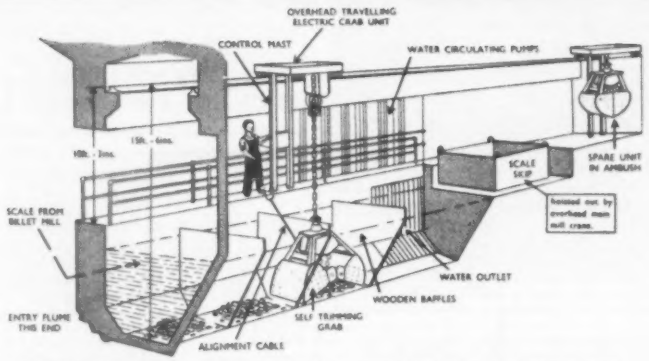
Recovery of Scale from High Quality Steel

Scale formed in the production of stainless and other high quality steels is very valuable as it contains a high proportion of the expensive alloying metals such as molybdenum, vanadium, cobalt and chromium. Its recovery however, is highly problematical as most of it is removed from the steel billets as they pass through the primary and intermediate mills. The problem has been solved at the Stocksbridge works of Samuel Fox and Company Limited, by the installation of specially designed recovery grabbing cranes in the scale pit beneath the new intermediate mill. The plant was designed and installed by Michael and Partners Limited, of 26 Chatsworth Road, Chesterfield.

The pit was so designed that scale, falling from the rolls of the billet mill, is sluiced down by water over a weir and into a settling pit. One of the two crane operated self-trimming grabs then dredges the pit and lifts the scale into a waiting skip. The cross section of the pit is such that the width of the flat bottom is only 2 in. more than the full width of the grabs, thus ensuring almost complete recovery. To suit the very low headroom available, grabs of the special ring discharge type were designed having a fixed discharge height but a variable loading height.

The grab hoisting and traversing motions are controlled from a push button panel, of Geipel manufacture, mounted on a fabricated mast attached to the crab frame and easily operated from the walkway extending along one side of the scale pit.

The grab arms are of flexible design and terminate in a double pivot top pulley box centralized by extended interlocking fingers. As the grabs lift the scale from under water, the clamshells, crosshead and pulley box are self draining. The grabs have 4 to 1 reeving and a special chrome molybdenum alloy chain is used with precision cast steel chain wheels and special automatic locking mechanism. A high pressure greasing system with water repellent grease is used.



Valuable scale sluiced from rolling mills is recovered in this specially designed plant.

The grabs have a level struck capacity of 7·5 cu ft and an unladen weight of 17 cwt. Each grab is suspended from an electric overhead travelling crab unit supplied by George W. King Limited, of Stevenage. These crab units, complete with travelling control mast, are of the overslung 4-wheel type incorporating a "Mamouth" precision chain pulley lifting block and operating on a 6 ft 6 in. gauge cable, reeled on and off coiling drums into cable ducts alongside the crane track.

Although only four or five grab loads of scale are removed from the pit each working day, Samuel Fox and Company Limited asked for two complete units to be installed so that one could be used as a stand-by.

The BISRA Hover Pulley

The cost and weight of 'tin cans' for use as food and drink containers may be reduced by making them with tin-plate about half the thickness of that used at present. This almost paper-thin tinplate, while strong enough for its purpose, needs very careful handling during manufacture to avoid tearing or damaging its surface.

A conventional electrolytic tinplating line employs about 70 guide rolls, of which a high proportion must be driven to avoid excessive tension in the strip. However, with very thin tinplate the design of guide rolls and of the speed controls for drive motors becomes difficult and costly if strip breakage is to be avoided and surface damage minimised. The problem is accentuated by the increase in speed of working which will be demanded from the tinplate lines of the future. BISRA, appreciating the need for a completely new approach to the problem, explored other possibilities. Calculations and laboratory experiments showed that fluid cushioning was technically feasible and economical as a means to support light gauge strip.

In the "hover pulley" arrangement, the conventional assemblies of rollers are replaced by a series of guide surfaces with a cushion of fluid (gas or liquid) between them and the moving strip. The cushion is formed by injecting a quantity of low pressure gas or liquid between the strip and the guide surface. The principle is similar to that used in hovercraft vehicles in that a pressure rise occurs within the area bounded by annular (slot) jets, if these jets are in close proximity to a boundary surface.

The resulting great reduction in friction losses and the elimination of rolls with high moments of inertia means that less power is required to move the strip, especially during speed changes; also, the strip need not be under high tension to preserve correct track and its surfaces will not be marked by contact with rolls.

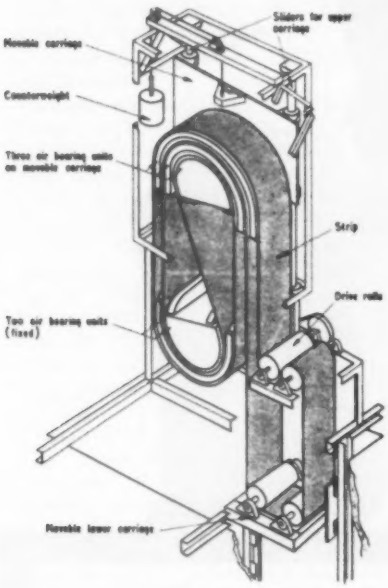
Some typical experimental figures, as an example, show that a single semi-cylindrical air cushioned bearing of 2 ft dia, to support 36 in. wide thin tinplate under a tension of 150 lb, requires an air supply of 980 cu ft/min at a pressure of 27 in. water gauge. This is

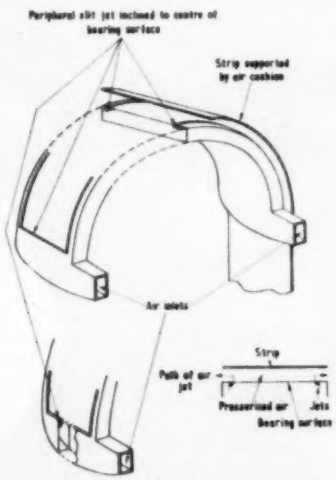
equivalent to a fan horsepower of about 9 bhp, allowing for duct losses and fan efficiency. An important design parameter has been to keep the air pressures required within the capabilities of a fan, which is relatively cheap to install and maintain.

Fluid cushioning systems offer possibilities of novel and more compact forms of plant design, leading to a reduction in capital costs. One such novel design is a labyrinth looping tower devised by BISRA, of which a pilot scale unit using 12 in. wide strip has been operating in the Association's laboratories for the past six months. A similar arrangement can be used for the support and guidance of strip in a liquid processing tank, whereby a given length of strip can be accommodated in a tank of smaller volume than that required for a conventional serpentine arrangement.

Head Wrightson have shown a keen and active interest in the hover pulley and a pilot rig for handling full-width strip has now been constructed by the Head Wrightson Research and Development Department.

The rapid progress of this project, from the inception of the idea in 1959 to the recent construction of a full scale pilot plant, has been due to the close cooperation between Head Wrightson and BISRA, acting under strong stimulus from a member firm.





Left, labyrinth looping tower. Above, semi circular air bearing unit.

Protection Against Electrical Faults

The Coal and Other Mines (Electricity) Regulations, 1956, require that in any transformer at a mine, suitable provision be made to guard against danger arising from the charging of lower voltage components by contact with or leakage from higher voltage components.

This requirement has created difficulties when the method of earth fault protection for the lower voltage system entails the severe restriction of fault currents which may flow should a line to earth fault occur on the lower voltage system.

Mr. E. Maloney, of the National Coal Board's Electrical Branch, has found that the regulation can be met by connecting the output line(s) of the transformer and the earth of a device, such as a spark-gap unit, which will short-circuit should the line to earth voltage exceed a value which is considered safe. Operation of the device would cause the earth fault protection equipment on switchgear feeding the transformer to open.

Should one of the devices fail accidentally and cause a short circuit between a lower voltage line and earth, such a fault could be made to cause the lower voltage earth leakage system to operate. Protection, as required by the regulation, is provided by the switchgear feeding the transformer. To give dual protection, the lower voltage system of earth leakage protection could easily be arranged to operate under conditions of higher voltage system to lower voltage system fault.

The value of current flowing through the spark-gap unit under conditions of fault between the higher and lower voltage system can be restricted by placing a current restricting device, such as a choke or resistor, in the path of the fault current.

An Extension of Standard Prefixes

In the modern engineering world units are getting both bigger and smaller. The 'kilo' (1000 times unity) is a small unit by many modern standards, leading to 'mega' (10^6 times unity) and later prefixes—'giga' (10^9 times unity) and 'tera' (10^{12} times unity). At the other end of the scale the prefix 'micro' for one-millionth has now been followed by 'nano' (10^{-9}) and 'pico' (10^{-12}), the latter already familiar to electronic engineers.

International standardization on such prefixes is obviously important—to avoid, for example, confusion between the American 'billion' or 10^6 and the English 'billion' or 10^{12}. The following list of international prefixes, therefore, should provide a useful reference, particularly to engineers not fully conversant with some of the modern terms.

prefix	*order*
Tera	1,000,000,000,000 or 10^{12}
Giga	1,000,000,000 or 10^9
Mega	1,000,000 or 10^6
Kilo	1000 or 10^3
Hecto	100 or 10^2
Deka	10
	UNITY
Deci	$\frac{1}{10}$ or 0·1 or 10^{-1}
Centi	$\frac{1}{100}$ or 0·01 or 10^{-2}
Milli	$\frac{1}{1000}$ or 0·001 or 10^{-3}
Micro	$\frac{1}{1,000,000}$ or 0·000001 or 10^{-6}
Nano	$\frac{1}{1,000,000,000}$ or 0·000000001 or 10^{-9}
Pico	$\frac{1}{1,000,000,000,000}$ or 0·000000000001 or 10^{-12}

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In Brief . . . .

Notes on New Materials, Plant and Machinery

Spray Unit.—Alfred Bullows & Sons Limited, Walsall, have added a 5-gal version of the Hydra-spray to the range of Graco units for which they are sole U.K. distributors.

Floor Topping.—Tretrol Epiflor, a trowel applied, oil and acid resistant floor topping, made by Tretol Limited, London NW9, is now available in two grades, heavy duty and standard.

Vacuum Brazing.—An electrically heated, cold retort furnace, designed for brazing components in vacuum, has been introduced by Royce Electric Furnaces Limited, Woking.

Transmission Equipment.—The Duro-Pulse industrial data transmission equipment for straightforward or up to 24-channel multiplex transmission over long distances is available in Britain from Honeywell Controls Limited, Greenford.

High Vacuum Valves.—A new range of high vacuum valves featuring unobstructed bores of 1, 2, 4, and 6 in. dia with hand or pneumatic operation is available on short delivery from Vacuum Research (Cambridge) Limited, Cambridge.

Ejector Door.—A new bar ejector door for swarf pulverizers designed to eliminate bar damage is made by Christy & Norris Limited, Chelmsford.

Fork-lift Truck.—An inexpensive battery-operated fork-lift truck with scissor-reach action has been introduced by Montgomerie Reid Engineering Company Limited, Bramley Green.

Mixing Valve.—Leonard 72, a mixing valve made by Walker Crosweller & Co. Limited, Cheltenham, combines thermostatic control of water temperature with flow control in one compact unit.

Strip Panelling.—Rectangular section tube is used to convey the heating fluid in the latest form of strip panelling manufactured by Brightside Heating and Engineering Company Limited, Ecclesfield, Nr. Sheffield.

New Solvent.—Imperial Chemical Industries Limited, London SW1, will make 1.1.1.-trichloroethane, a solvent specially suitable for cold cleaning, under the trade mark "Genklene".

Lock Viewer.—An illuminated probe primarily designed for viewing the inside of locks and padlocks through the keyhole and for viewing the inside of small components is made by P. W. Allen & Co., London N1.

Impulse Cylinder.—Consultair Limited, Birmingham 19, have added a one inch bore impulse cylinder to their range of high temperature pneumatic control equipment.

Electro-mechanical Valve.—A motor operated stop valve which can be used to regulate the flow of fluids is made by I. V. Pressure Controllers Limited, Isleworth.

Sand Separator.—The Krebs centrifugal sand separator now available in Britain from Neldco Processes Limited, Bracknell, is a device for removing fine sand, scale and similar materials from water.

Safety Torch.—A new industrial torch, with an unbreakable, all-plastics body of Rigidex is being produced by Watts Fincham Limited, London, to comply with ministry standards.

Cable-way Conveyor.—Based largely on their hand or power operated single track overhead handling systems British Monorail Limited, Brighouse, have introduced a cable-way system for flow production lines.

Aluminium Bearings.—Aluminium ball bearings, made by Roballo Engineering Company Limited, London W1, are fitted in military radars, missile launchers and gun turrets when weight saving is important, the largest so far supplied being of 90 in. dia.

Dust Collectors.—Unit dust collectors, supplied by Dallow Lambert Limited, Leicester, are in use in the new Helena Rubenstein cosmetic factory.

Couplings.—Conoseal couplings available from King Aircraft Corporation, Glasgow SW2, provide an all-metal joint capable of withstanding high pressures and extremes of temperature.

Small-bore Benders.—Chamberlain Industries Limited, London E10, offer a complete range of compact self-contained, small-bore tube benders.

Patenting Furnace.—The latest wire patenting installation at the Doncaster works of British Ropes Limited is a 700 kW furnace designed by Efco Furnaces Limited, Weybridge in conjunction with British Ropes engineering staff.

Air Heaters.—Econoil X19 and X24 air heaters, made by Nu-Way Heating Plants Limited, Droitwich, are of straight through horizontal type with axial flow fans and suitable for ducted and free air distribution systems.

All-round Camera.—The periphery camera developed by Shell Research Limited, Thornton, Cheshire, can take a continuous all round view and will photograph the inside surface of hollow objects.

3-Way Switch Units.—Flexible roller curve units for switching conveyorized items on to spur lines, left right or straight ahead are in production at Manufacturers Equipment Company Limited, Hull.

Photo-transistor Relay.—Photonomic Controls Limited, Leatherhead, have perfected a new photo-transistor relay unit designed to provide a basis for automatic control of numerous operations.

Bubblepak.—A new-style Bubblepak, designed to hold small items, required one at a time in separate airtight and moisture-proof compartments has been introduced by the packaging division of Gordon & Gotch, Limited, London EC4.

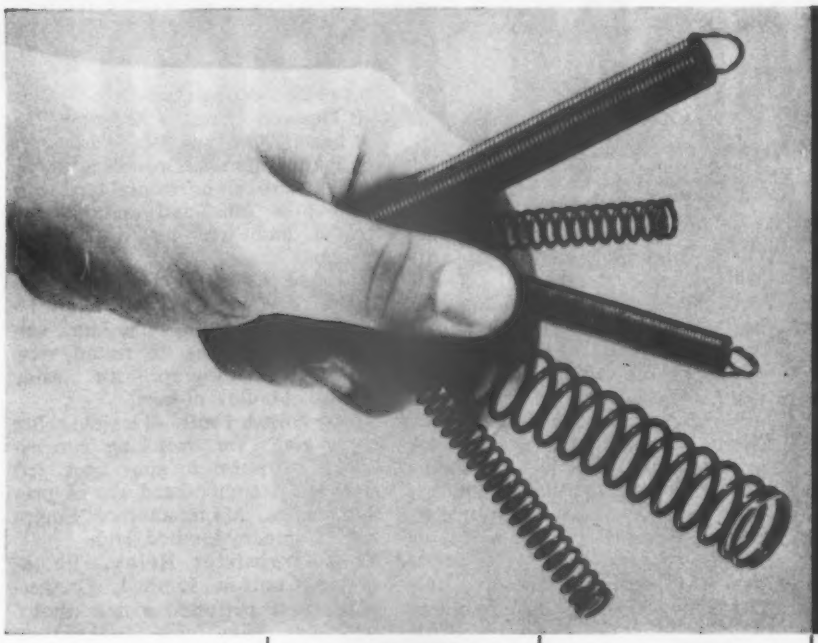
Power Generation.—An advanced type of electricity generating equipment, a development of the 3 MW "pocket power station on wheels" is being produced at Bristol Siddeley Engines Limited, Ansty, Coventry.

Wall Thickness Gauge.—An addition to the standard range of air gauges made by Teddington Industrial Equipment Limited, Sunbury-on-Thames, is a wall thickness gauge for plain bearings, cylindrical bushings and similar parts.

Fuel Oil Burner.—A new oil burner unit, the Senior, designed for use with residual fuel oil having a viscosity of 200 sec. Redwood I at 100° F is marketed by Wanson Company Limited, Borehamwood.

Tool Holders.—Additions to the Kendix range of holders made by Kennametal (Great Britain) Limited, Birmingham 4, include a further 13 sizes in both negative and positive rake series; in the latter series holders are available in certain styles in $\frac{1}{2}$ in. and $\frac{5}{8}$ in. square shank sections.

Self-cleaning Conveyor.—A fully enclosed, self-cleaning, en masse conveyor which can be adjusted to suit individual length and inlet/outlet requirements has been introduced by Christy & Norris Limited, Chelmsford.



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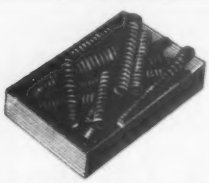

No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G., ¼" to ½" diam. **7/6**

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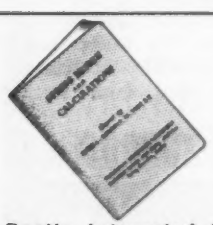

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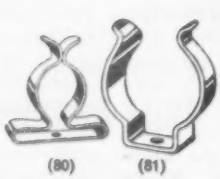

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books

Mechanization of Motion. By Lee Harrisberger. London, 1961; John Wiley & Sons Limited. 68/- net (by post 69/3). 363 pp. 5¾ × 9 in.

The author of this book takes the view "that design is not an art; that the creative thinking leading to the development of a unique and satisfactory solution is a rational process of synthesis and analysis". However much this point is arguable in general it is practicable in the context, for mechanism, as Paul Grodzinski's* work has shown, lends itself to synthesis by reason of the ordered system of elements of which it is composed. The technique is explained in the first chapter where the author shows how ideas are evaluated and developed—an introduction which could have the valuable effect of making the student realise how very much success depends upon experience. The basic elements are then described and the reader introduced to their combination in equivalent mechanisms, to the basic methods of mechanisation and the forms in which motion is encountered in machinery. The remainder of the book, comprising Parts II and III, deals with the mechanization of uniform rotary and nonuniform motion, the first dealing with rotary transmission, rolling motion, gearing and gear trains, and the second with cams, noncircular gear trains, and linkages. While there is a considerable technical content to the book its primary interest is undoubtedly the combination of this with the instruction given in ideal formation and solution synthesis, directed primarily to students. The combination is something relatively new and because of this it will probably interest many experienced engineers, if only as a means of comparing the modern ordered approach with the one which they have evolved for themselves.

* Paul Grodzinski, *A Practical Theory of Mechanisms*. Manchester, 1947; Emmott & Co. Limited.

Popular Lectures in Mathematics. 6 Vols. London, 1961; Pergamon Press Limited. Vol. I, 7/6 net (by post 8/1). Vols. II to VI, 10/- net each (by post 10/7 each). 57, 66, 58, 79, 86, & 60 pp. 5½ × 8½ in.

These six volumes are translations from the Russian and are detailed expositions of the particular subjects indicated by the titles, and while described as "popular" are for those with mathematical knowledge at Russian secondary school level. Vol. I., "The Method of Mathematical Induction", by I. S. Sominskii, explains the method of testing the validity of a hypothesis and contains a large number of examples and exercises. Vol. II., "Fibonacci Numbers", by N. N. Vorob'ev, deals with the numerical consequences of the classical rabbit breeding problem and gives examples of their occurrence in continued fractions and geometry. Vol. III., "Some Applications of Mechanics to Mathematics", by V. A. Uspenskii, uses visual conceptions of rods, sliding rings, cords and the like to create conceptions of the solutions to problems in geometry and the theory of numbers. Vol. IV., "Geometrical Constructions Using Compasses Only", by A. N. Kostovskii, deals with a specialized and rather restricted approach to practical geometry which might seem like art for art's sake were it not that experience of such exercises can be a short cut to profitable experience for the diligent. Vol. V., "The Ruler in Geometrical Constructions", by A. S. Smogorzhevskii, is in like case but with a different instrument. Vol. VI., the last of the series, by P. P. Korokin, with the title "Inequalities", is devoted to a study of, to quote the author, "some remarkable inequalities which have played a large part in various branches of higher mathematics, and with their application as far as finding the greatest and least values of numbers, and the calculation of some limits".

The treatment throughout is clear, systematic and to the point—which means that it is for those with sufficient mathematical knowledge (say O-level)—though decidedly specialized and therefore all the more interesting for those with the inclination.

Properties of Materials at Low Temperatures (Phase 1). General Editor, Victor J. Johnson. London, 1961: Pergamon Press Ltd. £10 net (by post £10-3-6). 161 pp. 8⅜ × 11 in.

This compendium is in fact a report prepared by the U.S. National Bureau of Standards Cryogenic Engineering Laboratory. It is in the form of separate sheets, mostly tables and charts, enclosed in a substantial binder fitted with release gear so that sheets can be removed and replaced, and there is space for further sheets such as the user of the material may wish to add from time to time. The importance at the present time of the data here collected stems from current needs of engineering designers working on nuclear reactors, controlled thermonuclear reactions, high altitude flight, missiles, rockets and the like. The present volume is described as "Phase I" and is derived from an extensive literature search, the sources forming the bibliographical and reference material recorded in Part III. The first two parts present data on ten specified properties of ten of the most common cryogenic fluids, and on three properties of a number of solids used at low temperatures. Metric units are used for primary coodinates but in all cases the charts have alternative coordinates in "English" or engineering units.

Further phases are planned for this valuable project and Phase II is stated to be already well under way.

Computer Applications, 1960. Edited by Bengamin Wittman and Andrew Ungar. New York, 1961; The Macmillan Company. 43/- net (by post 43/10). 193 pp. 6× 9¼ in.

In 1960 the Armour Research Foundation of the Illinois Institute of Technology sponsored a "Computer Applications Symposium", of which this book may be regarded as the official record. It is in two parts, the first dealing with business and management applications and the second with the use of the computer in engineering and scientific work. The first group ranges from the handling of ten million subscription records to economic research and general brokerage accounting. The second comprises the solution of normal numerical weather problems, systems and standards preparation for a new computer, computer design of optical lens systems, Loglan (a severely logical language) and the machine, data communication between remote machines, observations of Algol (a computer "language") in use, the role of a professional society in programme exchange, and a general discussion on engineering and

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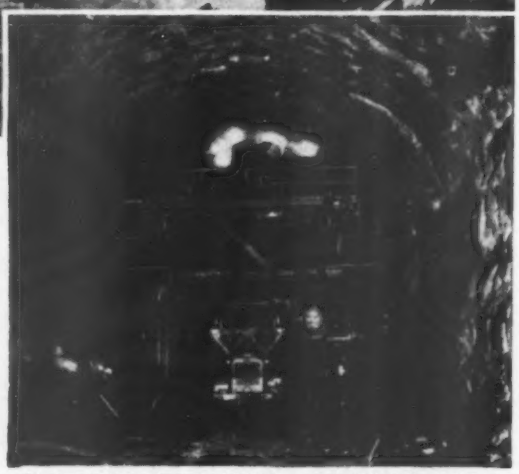

Photographs by courtesy of Societa Italiana per Condotte D'Acqua di Roma

Fixing steel wire netting with Rawlplug Roof Bolts to protect personnel from falls of rock. Here the tunnel has reached a depth of 2,300 metres of the total 5,850 metres of the Italian Section. (Atlas-Copco "Lion" rock drills are driving the tunnel from a 30-ton, four-decked drilling platform).

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scientific applications.

It appears from some of the remarks in these papers that the experience of computer specialists has not so far been uniformly happy. They are specialists and in most establishments seem to be limited to providing answers to problems. It is suggested—and this may well be true—that this will not bring the best results as regards the development of the computer in the organization. A constructive place will have to be found for them; either that or the people who want the answers will have to become proficient in the art of programming.

Steelwork Design.—Two new brochures have been published by the British Constructional Steelwork Association, Artillery House, Westminster, London SW1. Brochure No. 15, "Composite Construction for Steel Framed Buildings", presents for the assistance of the designer the sectional properties of a range of composite sections suitable for use in steel framed buildings. The use of concrete floors and steel beams in composite construction, wherein all or most of the compression due to bending is taken by the floor slabs and the tension taken by steel beams will result in considerable reduction in the weight of steel used for beams. Brochure No. 16, "Steel Frames for Multi-Storey Buildings", illustrates the application of B.S. 449/1959 to the design of multi-storey building frames. Two design examples are given with complete calculations, the first is the framework for a typical modern office block 20 storeys high and the second the framework of an 8-storey building in which wind loads are dealt with by utilizing the "portal method" resulting in bending moments due to wind loads on both beams and columns.

Ambulance Arrangements in Factories.—The existing legal requirements relating to ambulance arrangements in certain factories are amended in the Blast Furnaces and Saw Mills Ambulance (Amendment) Regulations, 1961, S.I. 1961, No. 2434, (H.M.S.O., price 3d. net) and the Chemical Works Ambulance (Amendment) Regulations, 1961, S.I. 1961, No. 2435, (H.M.S.O. price 3d. net), which came into force on January 19, 1962. The premises to which these regulations apply are blast furnaces, copper mills, iron mills, foundries and metal works, saw mills, factories in which articles of wood are manufactured and chemical works.

Rural Electrification.—At its eighth session the U.N. Committee on Electric Power decided, at the request of the Economic Commission for Europe, to undertake a study of rural electrification which would make available the results obtained in countries which had been dealing with such problems for a long time. A working party was subsequently set up and has now published its fifth series of reports. It contains seven studies by experts mainly from Eastern Europe and is obtainable through H.M.S.O.

Trading with Finland.—The London Chamber of Commerce sent a small mission to Helsinki in May 1961 at the invitation of the chairman of the Finnish-British Trade Association with the purpose of examining the current situation regarding Britain's exports to Finland. The recently published report of the mission will be of interest to many businessmen and is obtainable from the London Chamber of Commerce (Inc.), 69 Cannon Street, London EC4, price 5/- post free.

Grinding Carbide Turning Tools.—Following the introduction of cemented carbide cutting tools, various researches have been carried out by the Production Engineering Research Association with the aim of establishing the most efficient method of grinding. Some of the conclusions arrived at are contained in report No. 49 published by the association at Melton Mowbray, Leicestershire, price 7/6.

Data on Housing.—The United Nations "Annual Bulletin of Housing and Building Statistics for Europe, 1960 (obtainable from H.M.S.O., price 5/-) contains data relating to all European countries including the Soviet Union and for comparison purposes United States statistics are included. It provides valuable information concerning the relation of housing to population, type of houses, costs, rents, labour, etc.

Ionising Radiations.—Precautions for the protection of factory workers and others against the potential hazards and dangers arising from the use of ionising radiations in industry are discussed in a new booklet, "Ionising Radiations: Precautions for Industrial Workers", No. 10 in the Safety, Health and Welfare Series published by the Ministry of Labour. (H.M.S.O. 2/6 net).

Safety and Health in Industry.—At a time when the Chief Inspector of Factories report shows the 1960 total of industrial accidents to be 190,266, with 675 ending in death, a new edition of "Safety & Health in Industry" is available without cost from The Industrial Health and Safety Centre, 97 Horseferry Road, London, SW1. The seven major sections of this 150 page publication cover machine guarding, industrial health engineering, personal protection, material handling, housekeeping and maintenance, fire protection, and general matters.

New Standards

Roller bearing axleboxes for railway rolling stock (B.S. 3438:1961). Price 5/-.

Axlebox housings for roller bearings are dealt with in this standard, but no details are given of the bearing itself. Leading dimensions and suitable materials are given for a range of sizes of axlebox housings for locomotives and rolling stock fitted with bearings outside the wheels. A system of classification is used which provides for two alternative sizes of axlebox for each size of axle stub-end. Also included is a table which gives suggested loading for these stub-ends for various railway duties divided amongst locomotives, carriages, and wagons.

Copper for electrical purposes. Strip with drawn or rolled edges (B.S. 1432:1961). Price 7/6

In this new edition the scope has been narrowed so that it embraces strip only up to 6 in. wide, and only strip, the edges or corners of which are finished by a process which gives closer tolerance on width than are given by slitting, shearing or other edge cutting processes. Strip over 6 in. wide, and any strip or sheet manufactured to wider tolerances on width, are now included in the revision of B.S. 899.

Lubricating nipples. Part 2. Heavy duty lubricating nipples (B.S. 1486: Part 2: 1961). Price 6/-.

The standard deals with the overall dimensions, thread sized and body materials for heavy duty lubricating nipples. Two types of nipples are specified: industrial button-head nipples for use on heavy machinery and giant button-head nipples for use on heavy machinery where larger volumes and heavier bodied lubricants are required.

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BUSINESS & PROFESSIONAL

Personal

THE appointment of **Mr. W. Atkinson Adam, M.I.Mech.E.**, as managing director of the three British divisions of The Yale & Towne Manufacturing Company was recently announced. Three new directors to the British Divisions are also announced. They are **Mr. G. F. H. LeRoy** (works director) and **Mr. A. Langford** (technical director) of the Materials Handling Division, Wednesfield, and **Mr. C. G. Smith** (technical director) of the Lock & Hardware Division, Willenhall.

Mr. Arthur Sykes, O.B.E., B.Sc., Wh.Ex., M.I.Mech.E., has retired from the David Brown organization after 56½ years service. Mr. Sykes is an international authority on gears and gear cutting machines.

Dr. J. R. Mortlock, B.Sc.(Eng.), M.I.E.E., Mem.A.I.E.E., has been appointed assistant chief engineer (Engineering Services), AEI (Manchester) Limited. He retains his position as chief engineer, AEI Systems Engineering Department. **Mr. Tom Wightman,** assistant superintendent of the Large Turbine Department at the AEI Trafford Park Works, retired on November 30 after 37 years' service. He is succeeded by **Mr. R. Harrison** who joined Metropolitan-Vickers Electrical Company Limited, as an apprentice in 1937.

Mr. F. E. L. Copley and **Mr. A. C. Hobdell** have joined the staff of The Drop Forging Research Association.

Mr. Arnold Carr, deputy chairman and assistant managing director of Thos. W. Ward Limited, Albion Works, Sheffield, has been appointed joint managing director of the company.

Mr. F. H. Beasant, B.Sc., M.I.E.E., M.I.Mech.E., M.I.Loco.E., has been appointed manager-traction of Brush Electrical Engineering Company. He has been deputy manager since joining Brush in 1959.

Mr. H. C. Mayer, F.A.C.C.A., executive director and secretary of Griffin & George Limited and its subsidiaries, has been appointed deputy managing director of the group. **Mr. Martin Lyth, M.A., A.M.I.Mech.E.**, has recently been appointed director of supplies to Griffin & George (Sales) Limited.

Mr. S. Shepherd-Smith, managing director of Austin Hoy & Co. Limited, has been appointed to the board of the parent company.

Mr. Michael J. L. Brook has been co-opted to the board of Brook Motors Limited, Huddersfield, as production director.

Mr. P. McGregor, Ross M.A., has been appointed chief development engineer in charge of the engineering development design office of the Tube Investments' Research and Development Organization.

Obituary

WE regret to record the death last December of **Mr. George W. P. Page, A.C.G.I., A.M.I.E.E.**, who until his retirement at the end of 1953 was a member of the staff of the publicity department of the then British Thomson-Houston Company, Rugby.

WE regret to record the death in November last of **Mr. James Towell, Assoc.I.E.E.,** sales engineer, AEI Electronic Apparatus Division, New Parks, Leicester.

WE regret to record the death in December last of **Mr. D. O'Brien Minogue,** director of engraving at Edward Pryor & Son Limited, Sheffield, 10.

WE regret to record the death of **Mr. J. H. Norman,** depot manager of Croydon depot of Kerry's (Great Britain) Limited.

WE regret to record the death of **Sir Greville Maginness, K.B.E.,** of Tube Investments Limited.

WE regret to record the death of **Mr. John Waddell** in December, which brought to a close an association of nearly 72 years with The D. P. Battery Company Limited, of Bakewell, Derbyshire.

WE regret to record the death of **Mr. Frank Thompson-Schwab,** chairman of the Darwins Group of Companies and of Balfour and Darwins Limited.

Addresses

BLAW KNOX LIMITED, Construction Equipment Division, is now located in new headquarters at Short's Way, Rochester, Kent. All sales and engineering enquiries should be addressed to Rochester—Telephone number Chatham 41041.

SQUARE D LIMITED announce the opening of a new branch office at Druslyn House, De-La-Beche Street, Swansea. Mr. R. A. S. Richardson has been appointed branch manager.

POLLARD BALL AND ROLLER BEARING Company Limited, announce the formation of the Pollard Ball and Roller Bearing Corporation, with registered offices at 521 Fifth Avenue, New York 17, N.Y.

THE service department of Dowty Rotol Limited is now at Cheltenham Road, Gloucester. Telephone No. Gloucester 24431. Telex 4346/7. Dowty Fuel Systems Limited Service Department will continue to operate from Arle Court, Cheltenham. Telephone No. Cheltenham 53471. Telex 4346/7.

E.M.O. INSTRUMENTATION LIMITED, of Western Road, Bracknell, have now changed their name to The Barden Corporation (U.K.) Limited. The Barden Corporation of Danbury, Connecticut, are manufacturers of high precision bearings in America. The change of name has been effected to show the identity of interests which has now been established between the two companies.

THE southern area office of Fielden Electronics Limited has moved to larger premises at 181-183 Earls Court Road, London SW5. Telephone Freemantle 7866.

AN office of the Midland Region of the Home District Office Division of Associated Electrical Industries Limited was opened at Coventry on December 4. The address is Associated Electrical Industries Limited, District Office, Alma Street, Coventry. Telephone No. Coventry 24181. Mr. R. C. Jenkin is appointed manager. The office is responsible for sales of general industrial products made by AEI.

E. G. IRWIN AND PARTNERS LIMITED, design, development and consulting engineers, have now moved to Irwin House, 118 Southwark Street, London SE1. Telephone: WATerloo 1971 (P.A.B.X).

TOWN WOODHOUSE LIMITED, with registered office and accounts department at Wakefield Road, Brighouse, is the new trading company formed by the amalgamation of Fredk. Town & Sons Limited and Woodhouse & Mitchell.

Contracts and Work in Progress

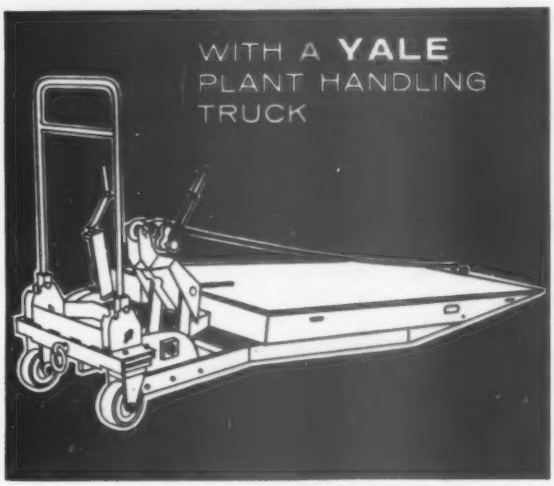
ASSOCIATED ELECTRICAL INDUSTRIES Limited.—Contract value £445,000 placed by the South of Scotland Electricity Board for switchgear for stations within the Edinburgh and Borders Area.

Order from the C.E.G.B. valued at nearly £14 million for 2000 MW of generating plant for Eggborough Power Station, Yorkshire.

Order from the China Light and Power Company for a 60 MW turbine generator with condensing plant, de-aerator and auxiliaries for the Hok-Un power station in Hong Kong.

Electronic Apparatus Division. Two orders covering the supply and commissioning of 40 flue dust monitors from Babcock & Wilcox Limited. The equipments are to be installed at C.E.G.B. generating stations at West Thurrock and Rugeley *Construction (Cables and Lines) Division:* Contract worth £118,000 from the London Electricity Board to reinforce the power transmission network in the Wimbledon area. *Motor and Control Gear Division*: An initial contract

cut your machinery handling time



One man and a Yale plant handling truck can shift machinery weighing up to 5 tons in a fraction of the time taken by more conventional methods.

This specialised truck has a tilting platform which can be angled until flush with the floor. The load is then drawn on to the platform by the Pul-Lift fitted at the front of the truck. When the load is secured (the platform is pierced with holes and fitted with strong rings) the truck is ready to move off.

The Pul-Lift is detachable and can be used for all kinds of other pulling and lifting jobs. Yale Plant Handling Trucks come in capacities of 2, 3 and 5 tons.

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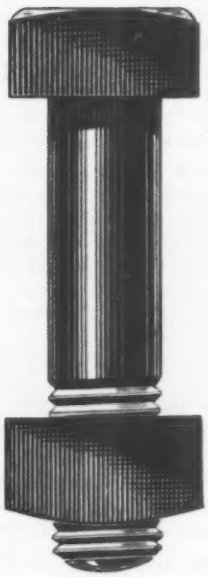

Send for our catalogues & Stock list

To
Charles Richards & Sons Limited
P.O. Box 23 Darlaston, Wednesbury, Staffs
Telephone: James Bridge 3188 (8 lines)

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valued at £182,000 has been placed by Electrical Drive Applications Limited, London, covering the supply of electrical equipment for nine Crabtree double-width printing presses for the 'Birmingham Post and Mail'. *Heavy Plant Division:* Orders worth nearly £440,000 have been placed by Stewarts and Lloyds Limited, in connexion with plans for re-equipment and new construction at Corby, Northants. Two overseas orders for aluminium smelters in Australia and Norway. *Motor and Control Gear Division*: Electrical equipment valued at £130,000 has been ordered by Ransomes and Rapier Limited for a giant walking dragline which they are supplying to Italy. *Transformer Division:* Order from the Southern Project Group of the Central Electricity Generating Board for four 400 MVA generator transformers for connexion to the 275 kV supergrid at Tilbury "B" Power Station, Essex. *Switchgear Division:* Order worth approximately £250,000 in connexion with a new C.E.G.B. 275/33 kV sub-station to be established at Aldwarke. *Electronic Apparatus Division:* Order of substantial value for radar display units has been placed by the Swedish Navy Board. These units are to operate in conjunction with coastal surveillance radar equipment previously supplied by AEI. *Construction (Cables and Lines) Division:* Contract worth £50,000 awarded by the South Eastern Electricity Board to reinforce the 11 kV distribution system between Dartford and Wilmington, in Kent.

Westinghouse Brake and Signal Company Limited.—Supplied to Richard Thomas & Baldwin Limited, Ebbw Vale. Rectifier equipment to provide d.c. for the preparation and tin plating of steel strip travelling at up to 1500 fpm—nearly 17 mph.

Sovex Limited, mechanical handling engineers, Erith, Kent,—Order for mail handling plant for the Oslo Head Post Office placed by the Norwegian Postal Administration.

Sturtevant Engineering Company Limited, Chemical Engineering Division.—Contract awarded by Midland Silicones for design and construction of tank farm additions complete with piping network. This will give an increased storage capacity of 120,000 gallons of raw materials and products.

Laurence Scott & Electromotors Limited,—Further orders received for electric motors for Vales Point Power Station, New South Wales, bringing the total value of contracts in hand for this station to over £300,000. The company also has substantial contracts in hand for power station auxiliary motors for other stations in Australia, New Zealand and Canada.

Herbert Hunt & Sons Limited, machine tool manufacturers, Elsinore Road, Old Trafford, Manchester.—Order for three reamer flute milling machines from Morse Twist Drill & Machine Company, Mass., U.S.A.

Efco Furnaces Limited.—Orders valued at over £100,000 for heat treatment equipment to be installed in the new Rootes factory at Linwood, near Paisley, Scotland, where the new small Hillman car is to be produced.

Suffolk Iron Foundry (1920) Limited.—Further order from Cuba worth £7,000 for oxy-acetylene equipment, including welding and cutting blow-pipes and spares.

William Boby & Co., Rickmansworth, Herts.—Order for automatic base exchange equipment for the Battersea plant of Express Dairy.

W. C. Holmes & Co. Limited, Huddersfield. Gas Cleaning Division.—Orders to the value of £225,000 for gas cleaning plant for English Steel Corporation Limited.

Strachan & Henshaw Limited, Bristol.—Order valued at more than £140,000 for high-speed iron ore unloading equipment at Port Etienne in Mauretania, West Africa. It has been placed by SABOST of Paris, who are the main contractors for the MIFERMA (Societe Anonyme des Mines de Fer de Mauritanie) iron ore shipping project. Order valued at over £136,000 placed by Robins Conveyors (South Africa) Pty. Limited, of Johannesburg, for high capacity ore wagon handling and unloading equipment to be installed at Port Elizabeth, South Africa.

Business Developments

Company Acquisitions

In agreement with John Brown & Co. Limited, Stanley Works (G.B.) Limited, tool manufacturers, have purchased all the shares in the power tool firm of S. N. Bridges & Co. Limited.

Vickers Limited are completing negotiations for the acquisition of 60% of the equity in All Wheel Drive Limited of Camberley; the balance of the shares, 40%, will be held by Clark Equipment International.

Trading Agreements

Following the recent acquisition of certain of the interests of the Pulsometer Engineering Company Limited of Reading by G. & J. Weir Holdings Limited, the products of Joseph Evans and Sons (Wolverhampton) Limited are now being marketed by G. & J. Weir Limited.

Agents and Distributors

The Owen Organisation has signed an agreement with V/O "Machinoexport" of Moscow for the distribution of a very wide range of Soviet welding equipment in most countries of the Commonwealth and the U.S.A.

Yale Trojan tractor shovels are to be sold and serviced in the United Kingdom directly to customers through the established sales and service organization of the British Materials Handling Division of The Yale & Towne Manufacturing Company, Wednesfield, Staffs.

Sole selling agents for the U.K. for valves manufactured by Industrial Pneumatics Limited are I. V. Pressure Controllers Limited, 683 London Road, Isleworth, Middlesex.

Rockwell Machine Tool Company Ltd., have been appointed sole U.K. selling agents for Sundstrand Arter rotary and cylindrical grinding machines.

Meeting Demands for Rubber Components

Demands from the aircraft industry in particular and from the electrical and mechanical engineering industries are being met by Precision Rubbers Limited of Bagworth, Leicester, by a new and enlarged press shop at their Silicone Works at Shepshed, and additional facilities at Bagworth, including a new engineering department and tool room. A new factory is being erected at Newbold Verdon, near Bagworth for the production of special new compounds for the aircraft industry, and this is expected to be in operation early in the new year. Research and development laboratories have also been extended.

Safety in Construction

In an effort to help check the continuing rise in accidents on construction sites, The Royal Society for the Prevention of Accidents, Industrial Safety Division has arranged special building and civil engineering accident prevention courses, the fourth of which will take place at the Civil Defence Staff College, Sunningdale from February 25 to March 2, 1962. In 1960 there were 20,584 reported accidents on construction sites and 277 of them were fatal. Applications should be sent to the Training Officer, Industrial Safety Division, RoSPA, 52, Grosvenor Gardens, London SW1.

Industrial Engine Conference

The Ford International Engine Conference was held in London in November last. It was the third such conference of the industrial engine division and was attended by 27 delegates from nineteen countries from all over the world.

Demonstrations

From February 5-16 The Press & Shear Machinery Company Limited, London will be holding a demonstration of the newest types of sheet metal working and forming machinery.

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This is a 180-ft rotary kiln producing 7 tons of burnt lime per hour in Israel. The burnt lime is used in cement manufacture and Edgar Allen & Co. Ltd. can also manufacture cement plants as complete "turnkey" jobs. The burnt lime can be hydrated for mortar or, on the other hand, used as a fertiliser. The Engineering Dept. of Edgar Allen also manufacture crushing and grinding machinery and ball mills to suit all applications.

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Calendars

The calendar issued by Mavor and Coulson Limited Bridgeton, Glasgow, has an attractive colour photograph of Scalpay Island, Skye.

Burton Griffiths and Co. Limited, a member of the B.S.A. Tools Group, have produced a handy turn-over desk calendar.

The beauty of the homeland is the theme of the calendar from Hawker Siddeley Industries Limited, Duke's Court, Duke Street, St. James's, London SW1, and this is illustrated by a charming colour photograph for each month.

Ciba (A.R.L.) Limited, Duxford, Cambs, on the other hand show the beauty of the Rhineland on their calendar. The twelve colour photographs are masterpieces.

Denys Law painted the picture of the Wherry Mine on the calendar issued by Holman Brothers Limited, Camborne.

The calendar of Lang Pneumatic Limited, Wolverhampton, has a tear-off daily pad.

Hunslet 138 hp and 270 hp diesel hydraulic locomotives in service in Spain form the subject of the painting illustrating the calendar of the Hunslet Engine Company Limited, Leeds 10.

Chloride Batteries Limited, Exide Works, Clifton Junction, Nr. Manchester generously give twelve delightful examples of female beauty from various countries—in colour photographs—with their calendar.

A large painting of Kinvarra, Co. Galway by Rowland Hill beautifully reproduced in colour accompanies the calendar of Alex Cowan & Sons Limited, Penicuik, Midlothian, Scotland.

Another charming painting of Ireland, this time of Fair Head, Co. Antrim by Maurice C. Wilks, appears on the calendar from Davidson & Co. Limited, Sirocco Engineering Works, Belfast.

Brooks Motors Limited, Empress Works, Huddersfield, have issued a turn-over desk calendar with full colour illustrations of old locomotives.

In their new calendar Edgar Allen & Co. Limited, Imperial Steel Works, Sheffield 9, have selected some colourful and interesting scenes depicting the beauty and industry of Sheffield and district.

The various products of Crofts (Engineers) Limited, Bradford, Yorks, which include couplings, gears, rollers, drives, clutches and brakes, illustrate the company's calendar. The same company have also issued a desk calendar for the first quarter of the year.

Components in Rubber

Tempered Rubber Components Limited, P.O. Box 17, Warren Street, Sheffield 4, in addition to manufacturing a range of moulded and extruded products in a wide variety of both natural and synthetic-based compounds, are expert in the bonding of rubber to metals.

They have issued a number of brochures detailing the various fields in which their products are used.

Steelwork

"Dorman Long Illustrated 1961" an illustrated booklet issued by Dorman, Long & Co. Limited, G.P.O. Box No. 1, Zetland Road, Middlesbrough, outlines the activities of the company during the past year. These included development work with steel and oxygen, the production of plastic coated steel sheets, expansion in West Africa, the erection of bridges in various parts of the world, and other work.

Broadcast and TV Equipment

The comprehensive range of broadcast and television equipment now offered by EMI Electronics Limited, Hayes, Middlesex is described in a new leaflet. Among the many cameras mentioned is a remotely-controlled dust proof colour camera suitable for industrial applications. A primary feature of the camera is its original and efficient optical system which gives outstanding light sensitivity and high quality colour reproduction.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Steel Castings

Hadfields Limited, East Hecla Works, Sheffield 9, have available a new booklet, No. 466S, detailing all the current British and American standard specifications for steel castings. A selection of European and Swedish castings specifications similar to the carbon steel specifications of B.S. 3100 is also given.

Welding Aluminium

With the increasing use of welding as a method of joining aluminium, and the considerable advances that have been made in technique during the past few years, Alcan Industries have brought up to date, and considerably enlarged, their book "Welding Aluminium". The new edition makes special reference to the arc-shrouded processes—tungsten inert gas (TIG) and metal inert gas (MIG) but space is now given to a description of other welding processes.

Renold Transmission Equipment

Hans Renold was the inventor of the bush roller chain, for which he secured a patent in the year 1880; this original Renold patent forms the basis from which all precision roller chain manufacture throughout the world has stemmed. Today the company is the largest producer of precision roller chains in the world, operating seven factories in the United Kingdom with further plants in France, Australia and Canada. A new leaflet illustrating a few products from the complete range as well as comprehensive catalogues are available from Renold Chains Limited, Renold House, Wythenshawe, Manchester.

Synthetic Fibre Belting

Turner Brothers Asbestos Company Limited, P.O. Box 40, Rochdale, have contributed, in no small way, towards advances made in belting technology by their research, development and extensive trials with new and improved products. Synthetic fibres are being increasingly used in beltings and this is the theme of a new booklet issued by the company which discusses the salient features of nylon, rayon and "Terylene" fibres and gives details of their strength and outstanding characteristics.

Mechanical Handling Equipment

Sovex Limited, Erith, Kent, are mechanical engineers, specializing in the design and manufacture of a wide range of mechanical handling equipment. A brief introduction to their works and to some of the installations they have made is contained in an illustrated booklet available from the company.

Hydraulic Machinery

The latest brochure, No. 505A from Baldwin Industrial Controls, Dartford, Kent, gives brief details of the range of equipment produced by the company's Fluid Power Division and includes all the main types of valves and cylinders for use with compressed air and oil.

Lincoln "Weldirectory"

Lincoln Electric Company Limited, Welwyn Garden City, Herts, have produced a new edition of their Weldirectory of Lincoln arc welding equipment, electrodes and accessories.

Replacing the former bound version, the new Weldirectory has been compiled to give a complete survey of the range in a concise, loose-leaf form. Copies may be obtained upon request from the publicity department at the above address.

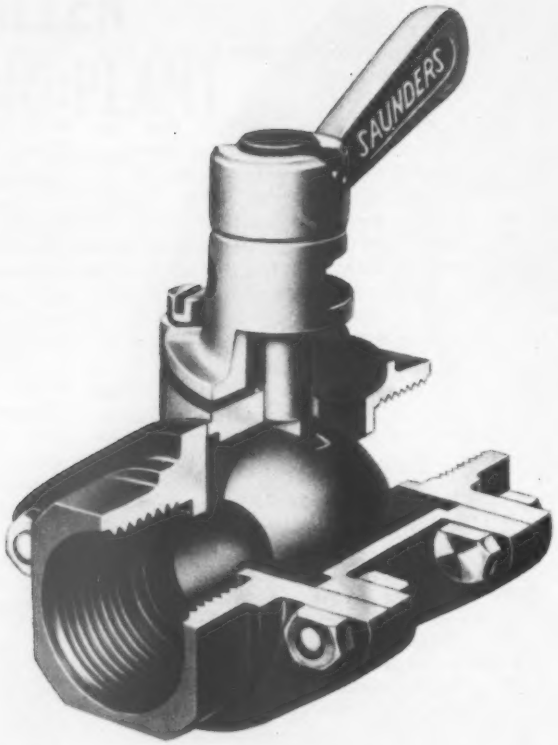
Industrial Plastics

Catalin Limited, plastic products manufacturers of Waltham Abbey, Essex, have issued a 16-page booklet "Catalin: catalyst to industry," containing examples of the contributions they have made to industrial efficiency. The company of today serves a wide variety of industries, ranging through foundry, coalface, car factory and battery plant.

Catalogues Received

Aqua-Clear corrosion and scale inhibitor field report. Kinnis and Brown Limited, Capel House, 54/62 New Broad Street, London EC2.

Progressive teeth hacksaw blades. Sanderson Brothers and Newbould Limited, Newhall Road, Sheffield.



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Blaydon (Co. Durham). Churchill Gear Machines Limited. Proposed office block at Shibdon Road. The architect is J. M. Angus, 3 Gallowgate, Newcastle upon Tyne.

Marshall Branson Limited, plant hirers. Plans have been prepared for the erection of welding and painting shops. The builders are Purdie Lumsden and Company, 25 Oxford Street, Newcastle upon Tyne.

Carlisle. The Michelin Tyre Company Limited are seeking a site for new premises on the Willow Holme Industrial Estate, Carlisle.

Gateshead. Reed Millican and Company Limited, glass merchants etc., Team Valley Trading Estate. The architects for rebuilding part of the factory are Arthur and Kirkup, 13 Swinburne Street, Gateshead.

Elders Walker and Company Limited, Sunderland Road, Gateshead, are considering the erection of a factory at the Saltmeadows for the making of neon lights.

Jarrow (Co. Durham). C. Lennig and Company Limited, chemical manufacturers, Jarrow. A large storage shed is proposed in Tyne Street.

Middlesbrough. Jordisen and Company Limited. Additions are proposed to printing works at Longlands Road. The architect is J. G. L. Poulson, 54 Albert Road, Middlesbrough.

Newcastle upon Tyne. R. A. Patterson and Company, motor dealers, Forth Street, are to erect showrooms, offices, workshops, etc., at Scotswood Road. The architects are Ryder and Yates, 87 Jesmond Road, Newcastle.

The Newcastle Chronicle and Journal Limited, Westgate Road, propose printing works, etc., at Pudding Chare. The architects are Cackett, Burns Dick and McKellan, 21 Ellison Place, Newcastle.

Prudhoe (Northumberland). Samuel Talbot (Engineers) Limited, Team Valley Trading Estate, Gateshead, are to erect a 16,000 sq ft factory at Low Prudhoe. The architects are Fennell and Baddiley, Bridge End Chambers, Chester-le-Street, Co. Durham.

Sunderland. Megator Pumps and Compressors Limited, 43 Berkeley Square, London W1, propose factory on one acre site at Sunderland.

Ericsson Telephones Limited. Work is in hand on factory extensions of 44,000 sq ft. The builders are R. Matthew and Company, Nile Street, Sunderland, and the architects, Neurick and Blackbell, 58 John Street.

Basildon. Carson Bros. (Productions) Limited, Honeywood Road. The architects for extensions are E. R. Collister & Partners, 41 Buckingham Palace Road, London SW1.

Biggleswade. Foster Instrument Company Limited, Pixmore Avenue, Letchworth. A new factory is to be erected at Astwick Road, Stotfo'd.

Birmingham. Wood & Perkins Limited, 42 Wright Street, are to erect a new works fronting New Summer Street, Aston.

Blackpool. Thomas M. Nutbrown Limited, Walker Street, are to build a new factory at Preston New Road and Clifton Road industrial estate.

A. P. V. Company Limited, Manor Royal, Crawley, are to build a new works at Preston New Road and Clifton Road industrial estate.

Bolton. B. Y. C. Engineers Limited, Progress Works, Whittaker Street, Radcliffe, are to erect a factory on Manchester Road industrial estate.

Bradford. W. N. Sharpe Limited, Bingley Road, are to build a new factory at Thorn Lane.

Chelmsford. Maywick Appliances Limited, High Street, Wickford, to build a new factory.

Cheltenham. S. P. Broughton Limited, High Street, are to erect a new works at Larry Cummins Hall, Stoneville Street.

Chester. Varnon Morris & Co. Limited, Mare Hey, Ewloe Green, Hawarden, are to erect a new factory at Sealand Trading Estate.

Colwyn Bay. J. & P. Jacobs Limited, Mochdre. Extensions are to be made to the factory.

Croydon. John Norman Limited, St. John's Hill, London SW11. Plans have been passed for the erection of a new factory at Gloucester Road.

New Factories

E. Holbrooke & Son (Croydon) Limited, Lower Addiscombe Road, are to erect a new factory.

Dagenham. Megam Units Limited, Hainault Estate. Factory extensions.

Essex Mica Company, Fowler Road. Extensions are to be made to the factory.

Derby. Bensham Limited are to erect a new factory at Holme Lane.

Dundee. Wylie, Shanks & Partners, Clairemont Gardens, Glasgow, C3, are the architects for the new factory for Lintafoam Limited, Loudwater, High Wycombe.

Eccles. Heavey & Co. Limited, Cawdor Street Works, Patricroft. A new factory is to be built at Fielding Street.

Enfield. Automatic (Nazeing) Limited. A new factory is to be erected at Alexandra Road.

C. A. Frost & Son are to build a new factory at Alexandra Road.

Hastings. Rastex Limited are to erect a new factory in Hurrell Road.

Heywood. Heywood Precision Engineering Company Limited, Rock Street, are to build a new works at Mount Street.

High Wycombe. Hard Alloys Limited, Beech Road. Extensions are to be made to the factory. The architects are Brocklehurst Cooper & Williamson, Tudor House, High Street.

Hull. Rose, Downs & Thompson Limited, Old Foundry to erect new works.

Hungerford. Chiltern Electrical Products, Church Way. The factory is to be extended.

Irvine. A. Cunningham Limited. Holm factory, Stewartson, Kilmarnock. A new factory is to be built on the industrial estate.

Leamington Spa. D. H. B. Tool Limited, Everseal House, Queensway. A new factory is to be built at Queensway trading estate.

London. Chiswick Products Limited, Burlington Lane. The architects for extensions to the factory are W. L. Twigg & M. W. Twigg, 30 Bouverie Street, London EC4.

Luton. Ellis & Goldstein Limited, 40 Guildford Street, are to build a new factory.

Manchester. Middleton & Mellor Limited are to extend their factory at Holyoak Street, Newton Heath.

James Barnes Limited. The Daisy Bank Works, Cheetwood Road, are to be extended.

Marple. Kay Bros. Limited, Reddish. New factory.

Petworth. Carter Bros. (Billinghurst) Limited, Billinghurst. Plans have been approved for the erection of a new factory at Wisborough Green.

Plymouth. Johnson & Baxter Limited, Wedgewood Village, are to extend their factory. The architects are H. J. Hammick & Son, Kintebury House, St. Andrews Cross.

Rochdale. John Holroyd & Co. Limited. The Holfos Rope Works, Rope Street, are to be extended.

Runcorn. Imperial Chemical Industries Limited are to spend £1,500,000 on extensions.

Stretford. British Arkady Company Limited, Skerton Road. Permission has been granted for works extensions.

Surbiton. Graseby Instruments Limited, Hook Rise. Extensions to works.

Mollart Engineering Company Limited, Hook Rise South. Factory to be extended.

Watford. Litholite Insulation & St. Albans Mouldings Limited. Extensions are to be made to the factory at Sandown Road.

C. M. G. Calver Limited, 76 Bushey High Street, are to build a new factory at Greycaines Industrial Estate.

Wembley. Clearex Products Limited, Heather Park Drive are to make extensions to their factory. The architect is S. Abel, Three Oaks, Arkley Lane, Barnet.

Cumbernauld. Telehoist Limited of Cheltenham are to establish a Scottish factory at the Blairlinn Industrial Estate.

Dundee. Holo-Krome Limited will occupy a second factory at Dundee Industrial Estate, to be built by the Board of Trade.

East Kilbride. Rheostatic Company Limited will occupy a 80,000 sq ft factory for the manufacture of thermostats and temperature control systems. They plan to expand to 200,000 sq ft within the next five years.

Edinburgh. North British Distillery Company Limited are to build a £130,000 bonded warehouse at Slateford Road, Edinburgh. Approval for plans has been given.

Glasgow. Lithgows Limited have begun a £400,000 development at their East Yard which will be integrated with the Glen Yard of William Hamilton and Company Limited, a member of the Lithgow Group.

Methil Fife. The South of Scotland Electricity Board is to build a £5 million power station at Methil Docks. Ross-Smith and Jamieson, Edinburgh are architects and Kinnear and Gordon, Edinburgh the civil engineers.

Port Glasgow. Ferguson Bros. (Port Glasgow) Limited are to build a £416,000 dredger for the Clyde Navigation Trust.

Port Glasgow. Aircraft Marine Products (Great Britain) Limited, manufacturers of solderless terminals have started production in a new 60,000 sq ft factory in Port Glasgow Industrial Estate.

Portobello. A. W. Buchan & Co. Limited, Thistle Potteries are planning an extension to their premises to meet the growing demand for stoneware in the export markets.

Durban, S. Africa. Turner & Newall Limited. New factory for their subsidiary, Turners Asbestos Products (Pty.) Limited to take over production of present factory at Driemanskap, Transvaal.

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Patents For Sale or License

THE proprietor of British Patent No. 780224, entitled "Hinged Lid Oiler", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

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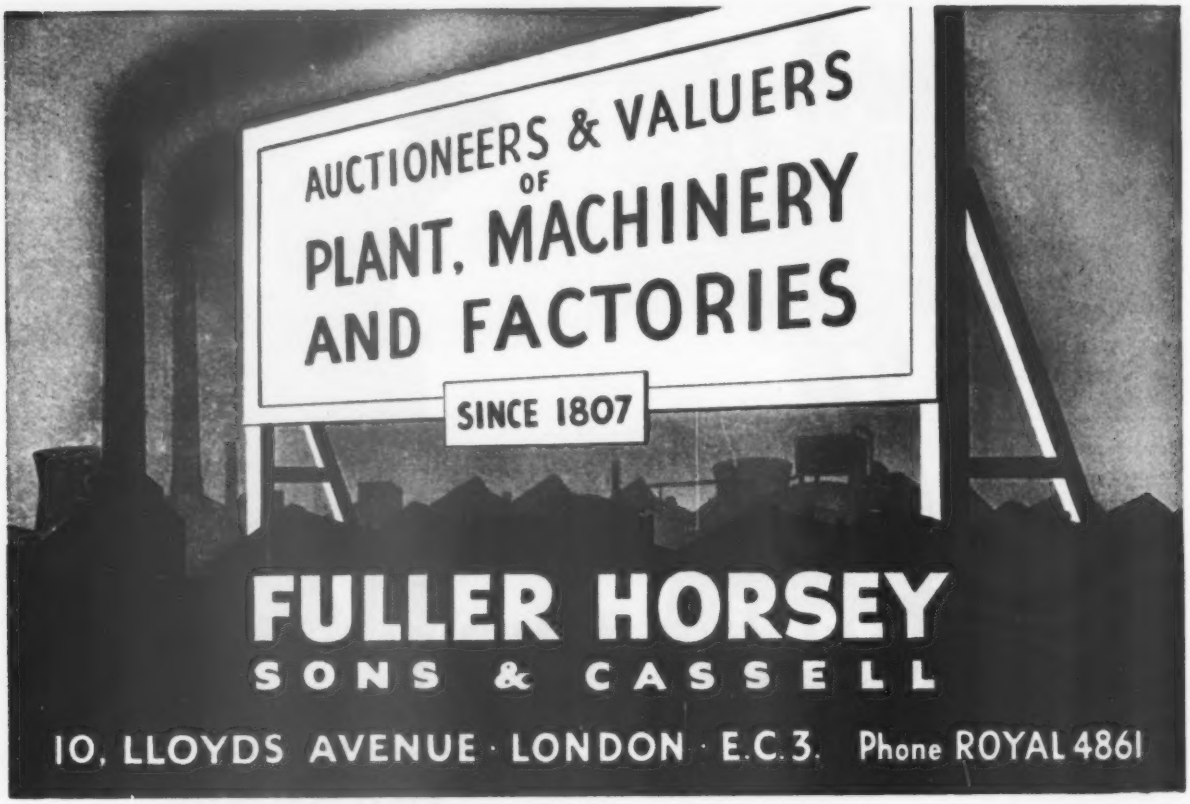

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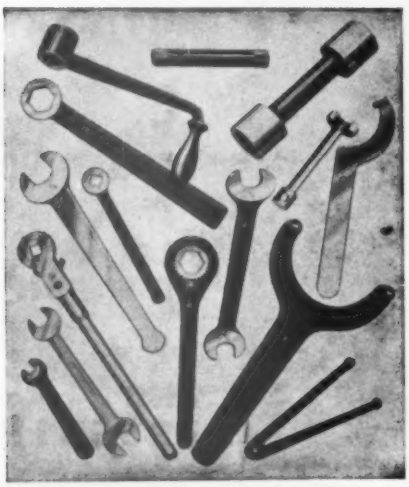

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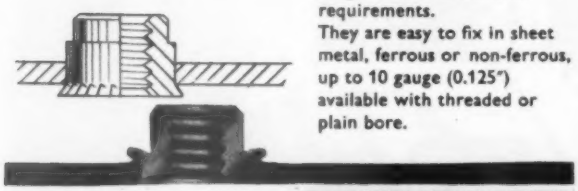

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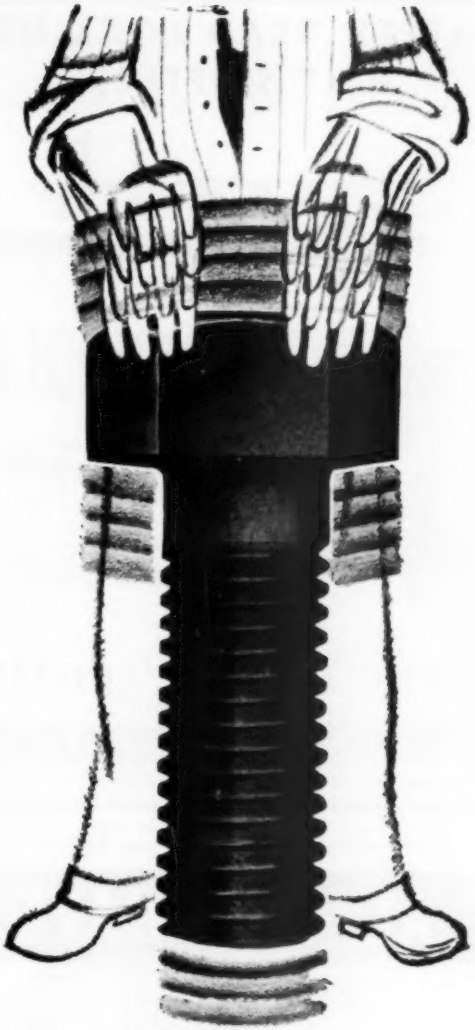

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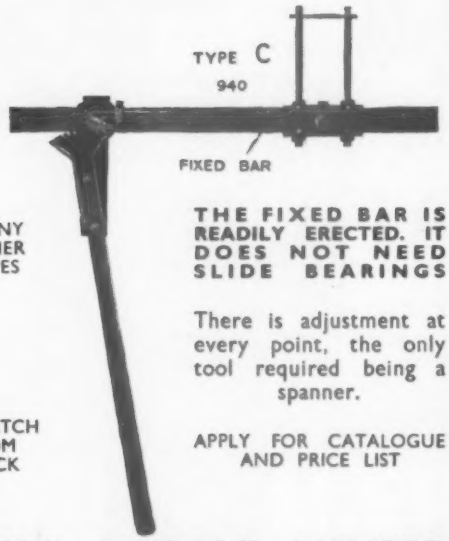

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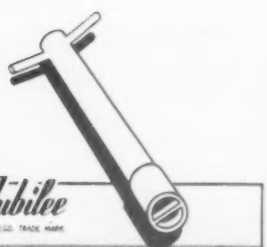

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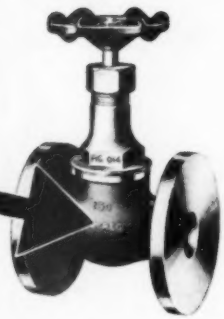

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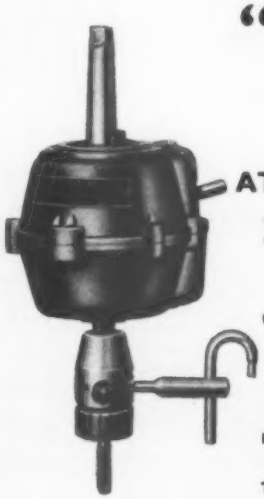

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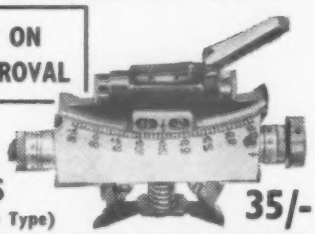

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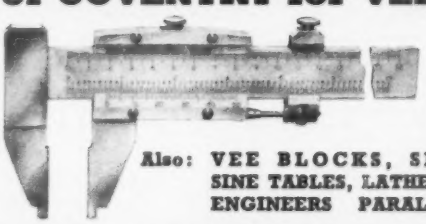

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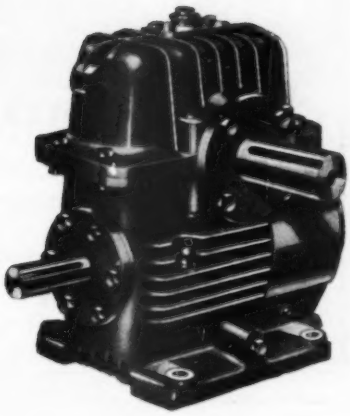

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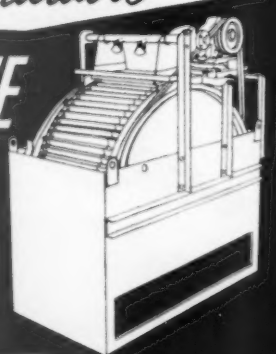

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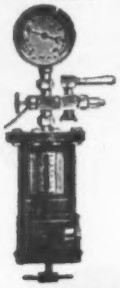

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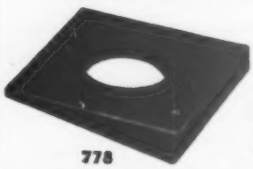

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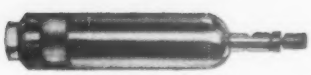

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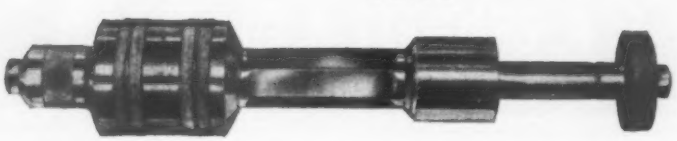

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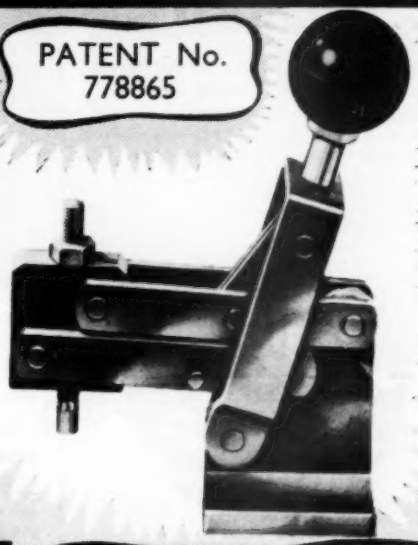

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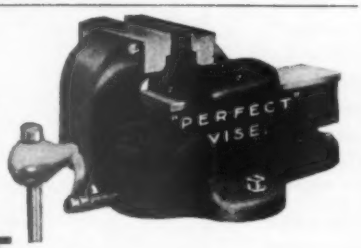

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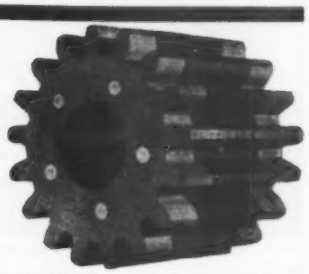

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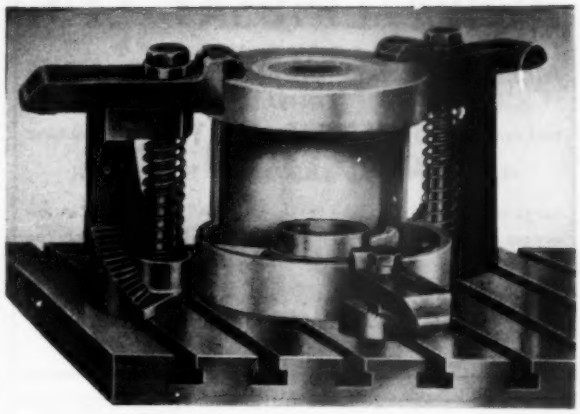

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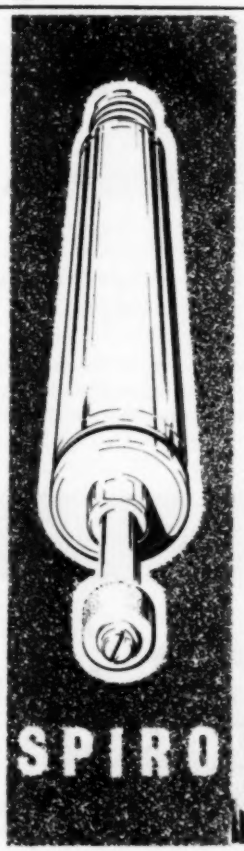

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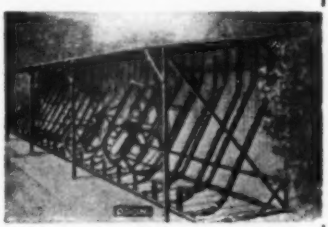

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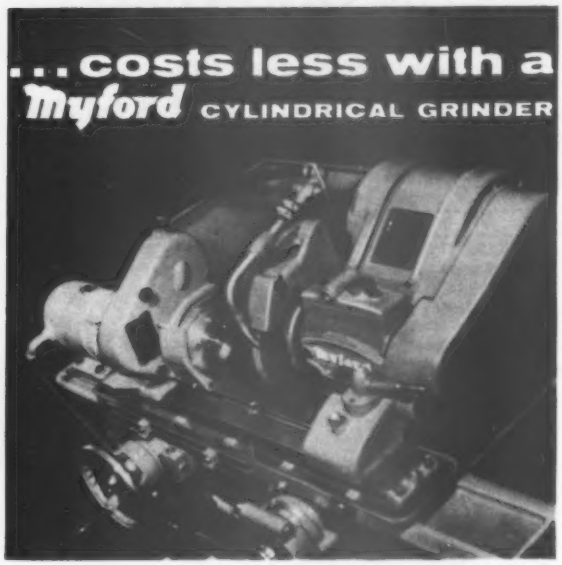

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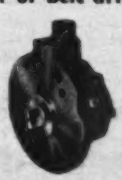

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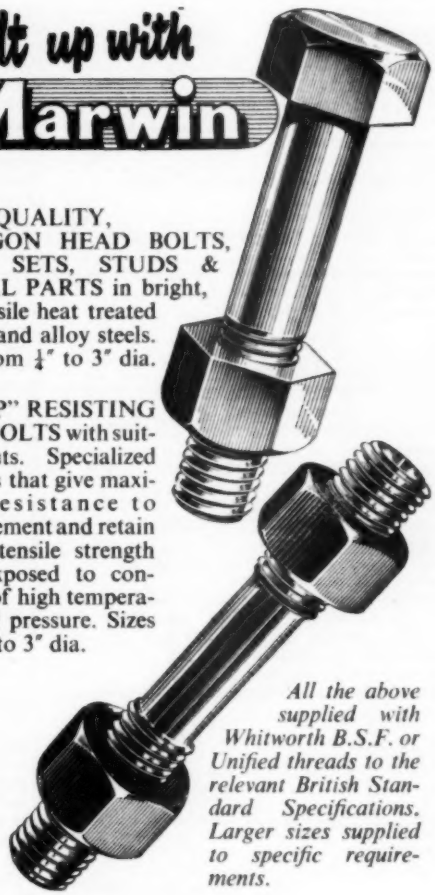

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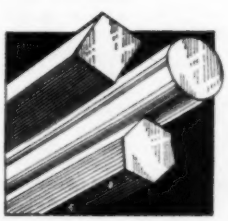

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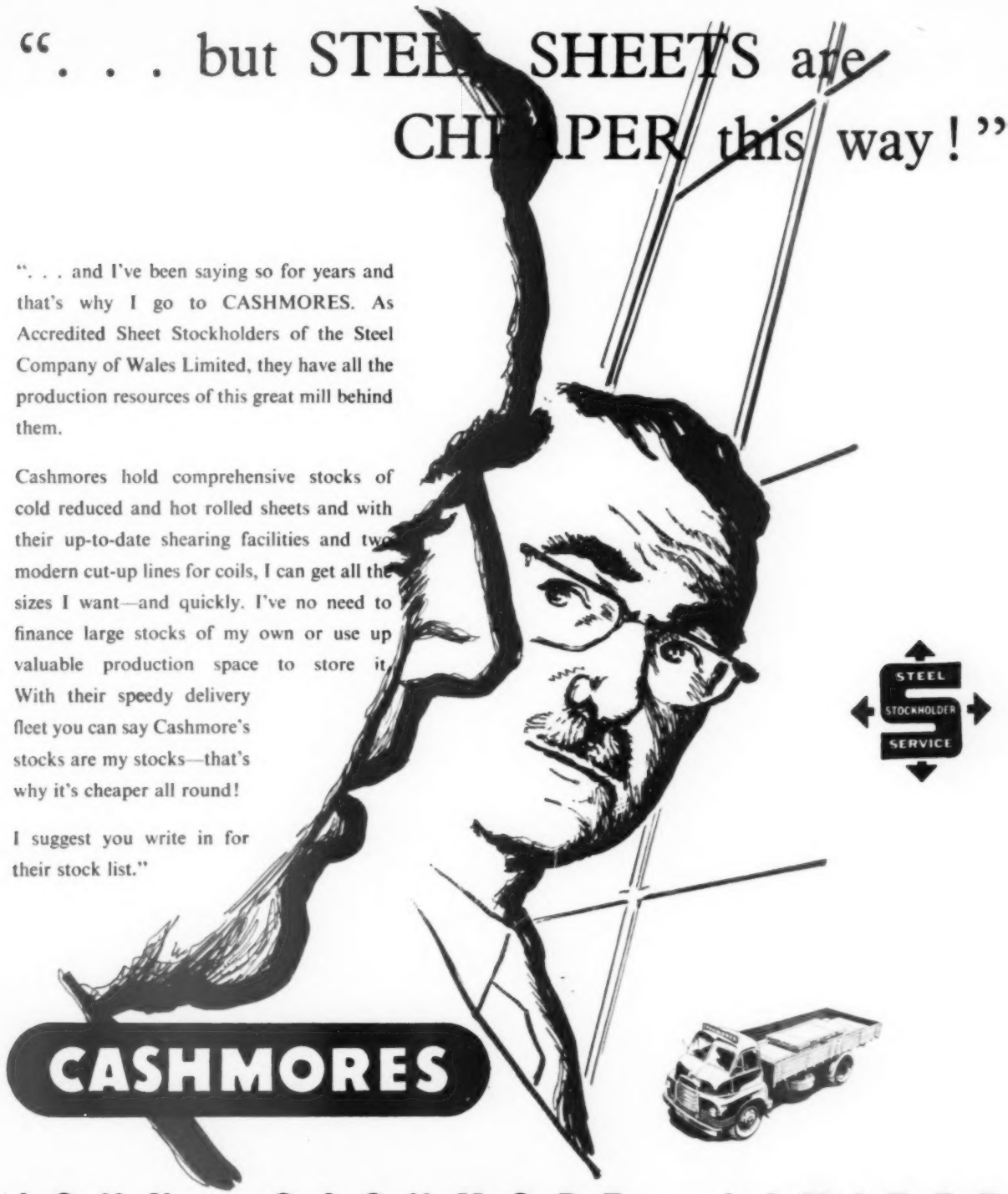

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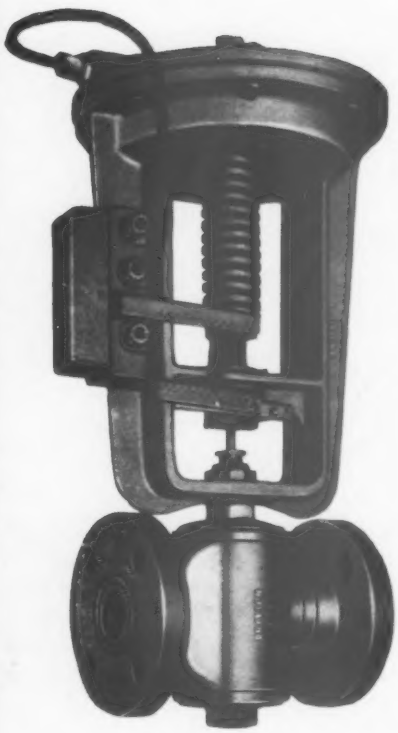

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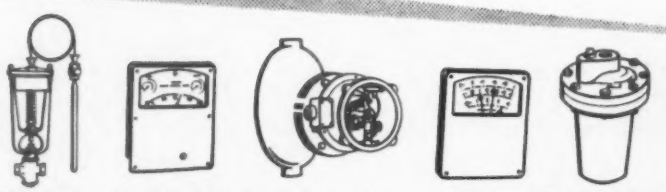

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